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A STATE EXPERIMENT IN CHEMICAL RESEARCH¹

By Professor G. T. MORGAN, F.R.S.

SUPERINTENDENT OF THE CHEMICAL RESEARCH LABORATORY, DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

At the Bristol meeting of 1875 my predecessor, Professor A. G. Vernon Harcourt, spoke to this section on the teaching of chemistry, and in the course of his very inspiring address he remarked that "the science of chemistry would advance more rapidly if it were possible to organize chemists into working parties having each a definite region to explore," and he went on to inquire, "Is such an organization in any degree possible?"

I propose this morning to describe the attempt recently made by a department of state, namely, the Department of Scientific and Industrial Research, to give effect to Professor Vernon Harcourt's prophetic vision. The answer to his question is in the affirmative. Such an organization is in some degree possible, and has actually become an accomplished fact. I must, however, leave for one of my successors in this

chair the further inquiry, "Can such an organization become permanent and still retain its primary and paramount function of chemical exploration?"

ORIGIN OF THE CHEMICAL RESEARCH LABORATORY

The work of the Department of Scientific and Industrial Research began in 1915, and during the ensuing ten years the department had at various times become interested in investigations of a chemical nature, such, for example, as (1) large-scale researches on the chlorination of methane; (2) large-scale researches on the production of formaldehyde, (3) investigations on the production of glycerine, (4) investigations on the manufacture of chemical products from fish residues, (5) general researches on the corrosion of metals, (6) general researches on high-pressure reactions, including the reactions between carbon monoxide and hydrogen.

These investigations, which were undertaken mainly

¹ Address of the president of Section B—Chemistry, British Association for the Advancement of Science, Bristol, September, 1930.

under the auspices of the Chemistry Coordinating Research Board, were carried out by isolated groups of workers, who were often located in widely separated laboratories. One group studied the corrosion of metals at the Royal School of Mines, another examined fish products in the Imperial College of Science and Technology, whereas a third experimented on the chlorination of methane and on the recovery of formaldehyde from waste liquors of wool-scouring at the Royal Naval Cordite Factory in Dorsetshire.

It soon became evident that some increase in economy and efficiency could be attained by bringing together under one roof these scattered groups of workers who would receive encouragement and stimulus by becoming part of a more centralized scientific organization.

A suitable site was chosen on the Bushy Park Estate in close proximity to the National Physical Laboratory and the Admiralty Research Laboratory, and here in 1924 the building of a chemical laboratory was commenced on a plot of land allowing ample scope for future expansion.

The original plans drawn out by the architects of H.M. Office of Works made provision for three laboratory units each of rectangular shape and built round four sides of a central courtyard. The front and back of the hollow rectangle consist of two two-story blocks; the front block designed for general and special small scale laboratories with the necessary offices, the back block arranged to accommodate workshops, service rooms and heating plant. The two sides of the rectangle, which consist of two single-story blocks with saw-toothed roofs, north lighted and with a clear head room of about sixteen feet, give adequate space for large-scale laboratories.

These buildings are constructed in steel and brick and so arranged that partitions can be readily removed for alterations or extensions. In the two-story blocks the floors and roofs are formed of hollow concrete tubes, but in the engineering section of the building, where heavy superloading had to be considered, a more rigid type of construction in steel and concrete floors was adopted. In the interest of economy, plaster and other relatively expensive internal finishings were omitted wherever possible, any distemper or paint being applied to flush-pointed brickwork. The floors were covered with stout cork carpet, laid directly on the cement rendering.

The laboratories are equipped with specially designed fittings, the framing and fronts are of stained British Columbia pine, whereas the bench tops and other portions subjected to hard wear are in teak or Iroko wood. The internal drainage to laboratory sinks is effected by open stone-ware three quarter circular channels finished with acid-resisting glaze.

Wherever exposed internally, structural steel and joiners' work are coated with acid-resisting paint. The benches of small scale and special laboratories carry five services—gas, water, steam, vacuum and compressed air. Each room is amply supplied with electric current (D.C.).

In conformity with the neighboring buildings of the National Physical Laboratory, a simple modern Georgian style was adopted in the design of the elevations of the new laboratory. The buildings are faced externally with multi-stone sand face bricks, reconstructed Portland stone being used sparingly in cornices, string courses and entrance doorways.

The construction of one of these units was started towards the end of 1924, and when scientific work was commenced in the autumn of 1925 about one third of the first unit had been built, although actually only one room was ready for occupation. The fitting of the remaining laboratories and workshop was, however, rapidly effected, and by the end of 1926 the whole of the available space was fully occupied, the staff then consisting of the superintendent and ten chemists, with one engineering assistant and ten members of the artisan, clerical and general staff.

The frontage to the half unit was commenced in November, 1927, and completed for occupation by Easter, 1928, and the staff was then increased gradually to its present total strength of about sixty.

Beyond a small addition for stores and workrooms completed in 1929 there has been no further extension of the building, so that after five years rather more than half of the first unit has been erected and put into commission. There has been no attempt to force the growth of this state laboratory, which is still to be regarded as being at an experimental stage.

ADMINISTRATION AND CONTROL

The work of the laboratory is conducted under the guidance of a Chemistry Research Board, which has taken over certain functions of the older Chemistry Coordinating Research Board. This board is charged with the duty of advising the department on the program of work to be undertaken at the laboratory and of exercising general supervision over its execution.

At the outset executive control was exercised by a part-time director of chemical research and a whole-time superintendent, but from 1927 to the present this responsibility has been vested in a whole-time director.

PROGRAM OF RESEARCH

At the present time the scientific and technical staffs are occupied on six specific items of research prescribed on the advice of the Chemistry Research Board, and "working parties of exploration" are detailed to these mandated researches by the director.

Now since these explorations were started at different times and in various circumstances, I propose to describe them simply in the order in which they have come under my notice. This arrangement is purely chronological, and has no bearing whatsoever on any order of merit or importance. Moreover it is essential to success in any research laboratory that each researcher should regard his own investigations as the most interesting and important in the world.

When thus arranged, the six mandated researches are as follows: synthetic resins, low temperature tar, high-pressure chemistry, corrosion of metals, chemotherapy and research on water pollution. In addition to these prescribed investigations a certain amount of general research is carried out at the discretion of the director.

SYNTHETIC RESINS

The growing importance of synthetic resins in chemical industry is gauged by the fact that the world's production of formaldehyde resins which was of the order of 9,000 tons in 1921 had increased to 13,000 tons in 1926, of which Great Britain was responsible for 16 per cent. as against 40, 24 and 8 per cent. derived respectively from the United States, Germany and France, other countries accounting for the remaining 12 per cent. Such resins are employed in the manufacture of moulding powders and electrical components. The production by industrially available means of resins of high dielectric capacity is a matter of national importance, and it was with this objective that an investigation of phenol-formaldehyde resins was begun even before the central laboratory was ready for occupation.

In May, 1925, a chemist was appointed to work at this problem in the University of Birmingham, and attention was directed to formaldehyde condensations with homologues of phenol, namely, the cresols and xylenols. Experience soon showed that *m*-cresol and 1:3:5-xylene were especially suitable for such condensations which in the case of the former phenol were extended to a semi-works scale.

According to the nature of the catalyst employed, phenol-formaldehyde condensations yield, in general, one or other of two distinct types of resin. Alkaline catalysts lead to the production of resins of "bakelite" type, which, although originally soluble and fusible, yet possess the property of moulding under the combined effect of heat and pressure into hard insoluble and infusible products constituting by far the more important group of phenol-formaldehyde resins.

Acid catalysts favor the production of resins of "novolak" type, which, being permanently soluble and fusible, are utilized principally as shellac substitutes in lacquers and varnishes.

Alkaline Condensations: After successful small-

scale tests, alkaline condensations of formaldehyde were performed on twenty-four pounds of *m*-cresol, carried out under factory conditions in a plant of semi-works scale comprising a jacketed reaction vessel, reflux condensers, washing and storage tanks, drying and incorporating vessels and a hydraulic press with heated platens.

A systematic study of this alkaline condensation revealed the presence of several crystalline intermediates which precede the formation of resin. The latter was employed in the production of moulded articles and of laminated boards for electrical testing.

Acidic Condensations: The chemical nature of formaldehyde-phenolic resins is still a matter of speculation, but the appearance of crystalline intermediates in the early stages of acidic condensations is of interest as denoting the course of these reactions. During these researches several crystalline intermediate products were isolated for the first time.

FORMALDEHYDE-KETONE RESINS

In the foregoing formaldehyde-phenol condensations, acetone is sometimes used as a medium, but since in the presence of alkalis this solvent condenses with formaldehyde to yield resins, the chemistry of the process has been elucidated by a study of the interaction of formaldehyde and the ketones under alkaline conditions. As the homologous series is ascended the formation of resin decreases. Acetone yields mainly resin and small proportions of γ -ketobutanol, $\text{CH}_3 \cdot \text{CO} \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{OH}$ and of the tetrahydropyrene formed by dehydration of the tetrahydric alcohol $\text{HO} \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CO} \cdot \text{C}(\text{CH}_2 \cdot \text{OH})_3$. Methyl ethyl ketone gives considerable proportions of the following mono- and di-hydric alcohols, $\text{CH}_3 \cdot \text{CO} \cdot \text{CH}(\text{CH}_2 \cdot \text{OH}) \cdot \text{CH}_3$ and $\text{CH}_3 \cdot \text{CO} \cdot \text{C}(\text{CH}_2 \cdot \text{OH})_2 \cdot \text{CH}_3$ with but little resin. Diethyl ketone furnishes no resin but leads to similar mono-, di- and tri-hydric alcohols.

LOW TEMPERATURE TAR

There is at the present time in this country no process of chemical industry which is more in the public eye than low temperature carbonization of coal. The matter is of supreme national importance, for the larger problems facing this mode of utilizing coal are both economic and technical and turn on the exploitation to the best advantage of the resulting products: smokeless fuel, gas, aqueous liquor and tar. Now since any marked appreciation can be expected only in the case of the last of these products it follows that processes tending to an increase in the value of the tar are of fundamental interest.

During the last five years a systematic study of the chemical constituents of low temperature tar has been in progress in the Teddington laboratory and, in our

experiments on this material, quantities of the order of 40 gallons have been handled in the semi-scale plant. The starting materials, supplied by H.M. Fuel Research Station as part of the government's scheme of scientific investigation into the utilization of our national resources of coal, consist of pedigree tars derived from coals of definite origin carbonized under carefully controlled and reproducible conditions.

It was soon found that although low temperature tar had been produced at carbonizing temperatures of about 600°, yet it could not again be heated even to comparatively low temperatures—round about 150°—without undergoing considerable alterations of a chemical nature. Accordingly, distillation processes were replaced by milder methods of extraction, and the tar was not heated above 120° until its more decomposable constituents had been removed.

A representative tar from a typical bituminous coal (Kinneil coal) was heated to 120° to remove light oils and adhering aqueous liquor, and the residue extracted by systematic use of solvents to separate it into its major constituents: neutral oils and waxes, aromatic hydrocarbons, bases, phenols and carboxylic acids. It was then noticed that each of these five main groups of products could be separated into two fractions, one portion consisting of crystallizable substances conveniently termed "crystalloids," the other portion composed of amorphous resinous materials to which the name "resinoids" was applied.

THE CRYSTALLOIDS OF TAR

Waxes and Neutral Oils: From the least volatile fractions of neutral oils, waxes are obtained melting over a considerable range of temperature, and X-ray analysis of the less fusible of these waxes has revealed the presence of hydrocarbon chains containing 26, 27 and 29 carbon atoms.

The neutral oils contain both saturated and unsaturated hydrocarbons and also oxygenated substances reacting with ferric chloride acid, HFeCl_4 .

Aromatic Hydrocarbons: Naphthalene, a characteristic major constituent of high temperature tar, is present in low temperature tar, together with β -methyl-naphthalene, but only in such small proportions that they have to be separated through their picrates.

The least volatile tar oils after removal of waxes and resins deposit on cooling a material analogous to the green grease of high temperature tar. This product consists principally of the methyl derivatives of anthracene, although a small proportion of this hydrocarbon itself may possibly be present. Oxidation of various fractions from this product leads to 2-methyl-anthraquinone, 2:6- and 2:7-dimethylantraquinone and 2:3:6-trimethylantraquinone. The proof of the

orientation of methyl groups in these anthracene derivatives has involved the synthesis of the hydrocarbons and of their quinones.²

Bases: The volatile bases of low temperature tar are mainly tertiary amines although a small amount of aniline was detected. The following bases were isolated and purified through their crystalline mercurichlorides: pyridine, *a*-picoline, 2:4- and 2:6-lutidines and symmetrical collidine; quinoline and quinaldine were isolated as picrates.

Phenols: Low temperature tars contain a high proportion of material extractable with aqueous caustic soda, but only a portion of this soluble extract consists of true phenols, the remainder is composed of non-phenolic substances which, however, dissolve in solutions of the alkaline phenolates. These non-phenolic materials are recovered from a caustic soda extract of the tar either by agitation with an organic solvent such as chloroform or more simply by saturating the alkaline extract with salt. The true phenols remaining in the alkaline solution are separated into crystalline and resinous portions by solution of the former in light petroleum. Further fractionation of the petroleum soluble phenols has led to the isolation of the following compounds: phenol, the three cresols and five of the six possible xylenols. Bacteriological examination of the phenols of low temperature tar has shown that their germicidal value increases with rise of boiling point to an optimum fraction boiling at 140–170° under 5 mm pressure. Moreover, it has been found that direct chlorination of these higher phenols of low temperature tar increases considerably their germicidal potency.

THE RESINOIDS OF TAR

With each class of crystalloid in the low temperature tar there is present a corresponding resinoid which constitutes the least volatile portion of each major fraction. These products, which are termed respectively resinenes (neutral resins), resinamines (basic resins), resinols (phenolic resins) and resinic acids (acidic resins), are obtained as amorphous powders after extraction of the corresponding crystalloids with petroleum or other suitable solvent. These resinous tar products are promising materials for further research from both scientific and industrial view-points.

An extension of the solvent method of extraction to other varieties of tar from wood, peat, lignite and bituminous coal has revealed the presence in each tar of the four classes of resins, although in wood tars the amount of resinamines was very small. Coal tars produced by carbonization at high and at intermediate

² *Journ. Chem. Soc.*, 1929, 2203 and 2551.

temperatures show considerable variations in their resin contents.

AQUEOUS LIQUORS OF COAL CARBONIZATION

The aqueous liquors which accompany low temperature tars have been extracted systematically with organic solvents in quantities of 30 gallons at a time, and in this way phenol, *o*-cresol, catechol and its two methyl derivatives, resorcinol and quinol, have been isolated, together with a new type of resins to which the name resinolic acids has been given, as they are intermediate in chemical properties between resinols and resinic acids. Resinolic acids in the presence of ammonia are largely responsible for the dark red color of the aqueous effluents from gasworks. These aqueous liquors have also furnished on systematic extraction aniline, pyridine and α -picoline, and the series of fatty acids ranging from formic to *n*-valeric acids.

HIGH PRESSURE CHEMISTRY

During the past ten years increasing attention has been directed to the use of pressure as a means of facilitating the course of chemical reactions, and research on high pressure syntheses was started at the laboratory in 1926 on the recommendation of the Chemistry Coordinating Research Board, whose members were impressed by the possibilities revealed by the work of Patart in France and of the Badische Anilin und Soda Fabrik in Germany.

The plant required for this investigation was designed and built in the laboratory workshop, and the earliest experiments were carried out with hand compressors. Subsequently motor-driven compressors and circulators were added to the equipment. This plant was first tried out with catalysts of the Patart type (normal or basic zinc chromate) in order to gain skill and confidence in the process. It was thus found that on passing the mixed gases (1 vol. CO, 2 vols. H₂) at the rate of 30,000 vols. per hour, measured at N.T.P. over unit volume of such a catalyst at 380° and under 200 atmospheres' pressure the hourly production of methyl alcohol was about twice the volume of catalyst space.

The addition of cobalt chromate or nitrate to the foregoing zinc chromate catalyst led to an interesting development, since with the more complex catalyst ethyl alcohol and other higher alcohols made their appearance, although methyl alcohol remained the predominant product. Small amounts of aldehydes and acids were also detected. By the use of mixed cobalt catalysts containing zinc, together with chromium or manganese, the following alcohols have been obtained in addition to methyl and ethyl alcohols: *n*-propyl, *n*-butyl, *iso*-butyl and *n*-amyl alcohols and racemoid 1-

methyl-propylcarbinol CH₃·CH₂·CH(CH₃)·CH₂·OH. So far only primary alcohols have been detected. Aldehydic products have been identified as follows: formaldehyde, acetaldehyde, propaldehyde, *n*-butaldehyde and also certain aldehydals arising from the condensation of the foregoing aldehydes and alcohols. Moreover, the synthetic products contain formic, acetic, propionic and *n*-butyric acids.

The addition of even small proportions of cobalt to copper-manganese oxide catalysts (Audibert type) has a marked effect on the production of ethyl alcohol and its homologues, and a similar result is noticed on replacing the cobalt in these catalysts by iron. Traces of alkali hydroxide promote the formation of higher alcohols, and in this respect potash is more efficacious than lithia.

HELIUM FROM MONAZITE SAND

In addition to their synthetic experiments, the staff engaged on high pressure chemistry have brought to completion a research on the extraction of helium from the monazite sand conveyed to this country from Travancore for the manufacture of thoria and ceria required in the incandescent mantle industry. During this manufacture each gram of sand evolves 1 cc of helium at N.T.P., so that 100 tons of sand would discharge into the atmosphere approximately 100,000 liters of the gas. Our requirements of this raw material were entirely met through the kind assistance of the late Mr. Edmund White, formerly managing director of Messrs. Thorium, Limited.

The gas was liberated by heating the monazite at 1000° in heat-resisting steel pots in a stream of carbon dioxide, and the issuing gas was passed over cupric oxide at 500° to oxidize hydrogen and carbon monoxide. Carbon dioxide was then removed by aqueous caustic soda and the residual gas passed over metallic magnesium at 600° in order to remove nitrogen and over metallic calcium at 580° to eliminate the remaining impurities. Several hundredweights of sand were thus treated and returned to Messrs. Thorium, Limited, who found that they could still employ the heated material in their process providing that it was mixed with a certain proportion of raw sand. The purified gas containing 99.5 per cent. of helium was compressed into storage cylinders.

CORROSION RESEARCH

The researches on corrosion were originally started by a committee of the Institute of Metals in 1916, and after eight years the more scientific developments of these problems were undertaken by the Corrosion Research Committee of the Department of Scientific and Industrial Research, this work being pursued in the metallurgical department of the Royal School of

Mines until the workers concerned were transferred to Teddington at Easter, 1928.

CORROSION OF IMMERSSED METALS

Research on the corrosion of immersed metals has been concentrated on an attempt to put the theory of this phenomenon on a secure quantitative foundation. For although earlier work in this country and in the United States had furnished a qualitative explanation of corrosive action in water or in salt solutions, yet this description of the process postulated the influence of more than a dozen factors on the corrosive rates of immersed metals. Accordingly, one aim of the present research is to acquire precise information as to the interaction of these factors, and another objective is to ascertain whether the lack of reproducibility in corrosion experiments is inherent in the corrosion process itself or whether it is due to imperfect regulation of all variables. Among these factors are purity of materials: metal, water, salt and atmosphere, constancy of temperature and pressure, and freedom from mechanical agitation. Zinc of a purity of 99.99 per cent., distilled water with an electrical conductivity of 0.058 gemmhos at 20° and purified oxygen were employed, and all experiments were carried out at 25° within a temperature range of $\pm 0.02^\circ$ over long periods of time, sometimes for upwards of six months.

Measurements of oxygen absorbed, corrected for any hydrogen evolved, made at frequent intervals during the course of such experiments have enabled one to plot continuous corrosion time curves which are often sufficiently smooth and regular to be investigated mathematically.

The apparatus employed for this purpose is shown among the exhibits from the laboratory. Originally designed for zinc it is now being used extensively for work on iron and steel.

Oxygen passes through water or salt solutions to the immersed metal either by diffusion or convection, but the latter mode of transference is by far the more effective at more than very shallow depths. Convection currents may arise in a salt solution owing to four different causes: (1) temperature changes, (2) density changes produced by evaporation at the surface layer, (3) density changes produced by differences of oxygen concentration, (4) mechanical agitation. The apparatus employed for these quantitative experiments is immersed in a thermostat and corrosion occurs in a closed space within it so that the effects of temperature changes (1) and evaporation (2) are practically negligible, and special precautions are taken to prevent agitation (4). Accordingly, by removing oxygen from the neighborhood of the metal, the corrosion process produces convection currents of the third category due to changes in concentration of

oxygen. The velocity of these convection currents depends on the difference in density between the solution saturated with oxygen at the liquid surface and the solution next to the metal. Assuming that the latter solution contains very little oxygen, the velocity of convection will probably be proportional to the solubility of oxygen in the liquid, but the amount of oxygen carried by the current is also proportional to its solubility. Hence, the rate of corrosion (y) should be proportional to the square of the oxygen solubility (x), a relation which is expressible by the equation $y = kx^2$. This assumption has been verified for on plotting the observed rates of corrosion against oxygen solubility one obtains curves of parabolic form.

Hydrogen evolution due to the interaction of water or salt solution with metals such as zinc or steel is of greater importance than is generally supposed. Determinations of the hydrogen liberated during zinc corrosion have shown that a very small amount of impurity has a considerable influence on the amount of gas evolved. In N/10,000 potassium chloride measurable quantities of hydrogen are obtained from 99.99 per cent. zinc, whereas no hydrogen was detected from zinc of spectroscopic purity. The proportion of zinc corrosion due to evolution of hydrogen increases with concentration of potassium chloride, and with 2N-solutions it amounts to 17.4 per cent. of the total corrosion.

When all the foregoing factors are taken into account, successive corrosion experiments exhibit a high degree of reproducibility and the curves indicate that duplicates differ from their mean value by 1 per cent. or even less. This constancy indicates that the corrosion of zinc and allied metals is not inherently erratic, but is quite a suitable subject for physico-chemical investigations.

ATMOSPHERIC CORROSION

Investigations of various types of indoor and open-air corrosion and of protective oxide films, previously conducted under the auspices of the Atmospheric Corrosion Research Committee of the British Non-ferrous Metals Research Association, were taken over by the Department of Scientific and Industrial Research in July, 1927. This work was continued at the Royal School of Mines until April, 1928, when the corrosion section was transferred to the Chemical Research Laboratory. The more outstanding results since obtained are as follows:

Composition of Green Patina on Copper Structures: Samples of the familiar green patina on exposed copper surfaces, obtained from typical localities, town, country, marine and urban-marine, were analyzed completely. Contrary to the general belief, basic copper carbonate was found to be not the prin-

eipal but only a minor constituent of the green patina. With the exception of the product from a purely marine atmosphere in which basic copper chloride predominated, the major constituent throughout was basic copper sulphate, and excess of basic sulphate over basic carbonate was greater in the rural than in the urban samples. Where urban and marine conditions coincided, basic sulphate predominated greatly over both basic chloride and basic carbonate.

It has recently been found that these constituents of the green patina tend to assume the chemical composition of the corresponding green copper minerals. In the limits, the basic copper sulphate of corrosion coincides in composition with brochantite of which the coordination formula is $[\text{Cu}\{(\text{HO})_2\text{Cu}\}_3]\text{SO}_4$, and the basic copper chloride of corrosion with atacamite $[\text{Cu}\{(\text{HO})_2\text{Cu}\}_3]\text{Cl}_2$. Basic copper carbonate on the other hand tends to assume the composition of malachite $[\text{Cu}\{(\text{HO})_2\text{Cu}\}]\text{CO}_3$. Complete agreement with the composition required by the coordination theory has been realized in corrosion products after 70 years' exposure and upwards. After shorter periods of exposure the basicity of the product is in a lower ratio than that of the corresponding minerals.

The complete analysis of these corrosion products entailed special precautions. The carbonates were decomposed by phosphoric acid instead of hydrochloric or sulphuric acid, and any hydrogen chloride and hydrogen sulphide simultaneously set free were eliminated by *p*-nitrosodimethylaniline and copper powder respectively.

Corrosion of Magnesium Alloys: The growing use of light magnesium alloys for motor-car and aircraft work has necessitated increased attention to the corrosive properties of these metals. In 1929 a research was begun with the object of discovering improved methods of protection and of learning more about the nature of the corrosion. More than 500 different protective coatings have been produced by chemical means and tested for resistance to sea-water sprays. Of these coatings a few are sufficiently promising to warrant further study.

CHEMOTHERAPY

In 1927 a joint exploratory committee of the Department of Scientific and Industrial Research and of the Medical Research Council decided that there was need for organized research in chemotherapy, and accordingly the Medical Research Council set up a permanent committee to advise them on investigations in this field. To this committee the department has nominated three chemical members, including the director of chemical research, and facilities have been afforded by the department for a staff of three chemists to work on problems based on an agreed program.

These chemists have already prepared a considerable number of organic compounds of possible utility in chemotherapy and these are being tested systematically under arrangements made by the permanent committee. This work of national importance is a joint effort of several groups of chemists working in different laboratories, so that a wide and thorough search for greatly needed drugs and therapeutic agents is in progress.

The Teddington contribution to these researches may be classified under the two following main headings:

1. *Analogues of Bayer 205 or Fournneau 309:* Last year in his presidential address to the physiology section of the British Association in South Africa, Professor W. E. Dixon referred to the serious ravages produced in that continent by sleeping sickness (trypanosomiasis), and his admirable survey of the position from the view-point of chemotherapy renders unnecessary any further elaboration of that aspect of the problem in the present summary.

The activity of medicaments of the Bayer 205 or Fournneau 309 type may depend more on the aggregate effect of the whole molecule rather than on the presence in the molecule of any particular group or arrangement. In this, as in other cases, there are no definite laws connecting therapeutic activity and chemical structure.

Compounds have been prepared in which the terminal aminonaphthalenedisulphonic radicals have been replaced by analogous complexes derived from aminocarbazole di- and tri-sulphonic acids or from the disulphonic acids of aminofluorene and of aminofluorenone, but so far the effect of this substitution has not been encouraging. The possibility of a beneficial introduction of arsenic into the fluorene nucleus has, however, been considered, and experiment has shown that trypanocidal activity is manifested when an arsinic acid radical is present in a fluorene molecule in conjunction with an amino-group.

2. *Organic Derivatives of Arsenic and Antimony:* During many years organic arsenicals have received much attention, whereas organic antimonials have not been subjected to the same careful scrutiny, partly owing to the fact that they are more difficult to prepare in a state of purity and partly because the curative results have been less promising.

Nevertheless, since antimony in organic combination appears to possess specific trypanocidal activity and some curative action in kala-azar, experiments have been made in the Teddington laboratory on the preparation of antimony analogues of the more successful arsenicals. Tryparsamide (phenylglycine-amido-*p*-arsinic acid) is used extensively in treating trypanosomiasis, and its antimony analogue has been under

examination. In the more stable meta series, phenylglycine-amido-*m*-stibinic acid and certain allied compounds show a slight trypanocidal effect. The antimony analogue of stovarsol (3-acetyl-amino-4-hydroxyphenyl arsinic acid) or more probably its internal dehydration product has also exhibited some therapeutic activity.

Concurrently with this study of organic antimonials further experiments have been made on organic arsenicals produced by condensing atoxyl successively with succinic anhydride, and with a base such as ammonia, methylamine, dimethylamine, piperidine or aniline. Certain of these derivatives have also exhibited a definite action on trypanosomes.

In addition to the preparation of antimonials directly applicable to therapeutic tests, our knowledge of the organic chemistry of antimony has been extended among aliphatic derivatives by the production of antimony analogues of the caecodyl group and in the aromatic series by the synthesis of cyclic antimonials analogous to the alkyl- and aryl-carbazoles.

WATER POLLUTION RESEARCH

This research originated from a joint request made to the Department of Scientific and Industrial Research by the Ministry of Health and the Ministry of Agriculture and Fisheries.

During the past two years, experiments have been in progress under the auspices of the Water Pollution Research Board on the base-exchange method of water softening. One of the objects of this work has been to determine the most satisfactory way of carrying out the process, such points having been examined as the effect of varying the rate of flow of water through the bed of base-exchange material and the quantity, concentration and time of contact of the salt solution used in regenerating this material. There are two types of base-exchange material in actual industrial use, treated minerals and synthetic products prepared by interaction of solutions of sodium aluminate and sodium silicate. It appears from the result of the Teddington experiments that with treated minerals the exchange of bases is confined to the outer surface of the particles whereas with the synthetic materials diffusion to the inner surfaces or into the mass of the gel is an important factor. This study of the base-exchange process has also been extended to the case of waters rich in magnesium.

Disintegration of the base-exchange materials and contamination of the softened waters by silica and alumina have been investigated. At the rate of flow employed normally in water softening, the silica content of the water is not increased seriously and is certainly not greater than that often encountered in untreated waters.

In addition to this practical work a report summarizing existing knowledge of the base-exchange or zeolite process for water softening has been compiled and published.

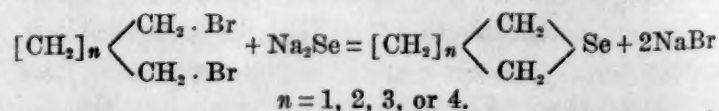
GENERAL RESEARCH

Investigation of complex aromatic hydrocarbons:

In 1926 the dyestuffs industry development committee of the Board of Trade suggested that further fundamental research was desirable on the following coal tar products: acenaphthene, carbazole, fluorene, perylene and phenanthrene. Two of these suggestions were adopted and, with the assistance of two chemists, the director, who is also a member of this statutory committee, undertook a study of acenaphthene and perylene, the work being continued until 1928. During this period considerable progress was made with the former hydrocarbon, the nitration of which was studied under anhydrous and hydrous conditions. For nitrations, in the absence of water, diacetylorthonitric acid and benzoyl nitrate were employed, the latter being a reagent discovered originally in 1906 by Professor Francis, of this university. Several new nitro derivatives were identified, and 2-aminoacenaphthene and 2-acenaphthenol (2-hydroxyacenaphthene) were prepared for the first time.

Higher Fatty Acids: In order to identify the waxes isolated from low temperature tar a parallel research was made on the synthesis of individual waxes from the higher fatty acids. Those waxes containing an even number of carbon atoms were produced electrolytically by Kolbe's classical synthesis (1849), whereas their homologues containing odd numbers of carbon atoms were prepared by a more modern process due to Grün, Ulbrich and Krezil (1926). By these complementary processes individual waxes containing 27, 30 and 34 carbon atoms were prepared for comparative purposes. This inquiry necessitated the study of several higher fatty acids, including arachidic acid, and in such cases analytical data were confirmed by X-ray analyses carried out in the National Physical Laboratory.

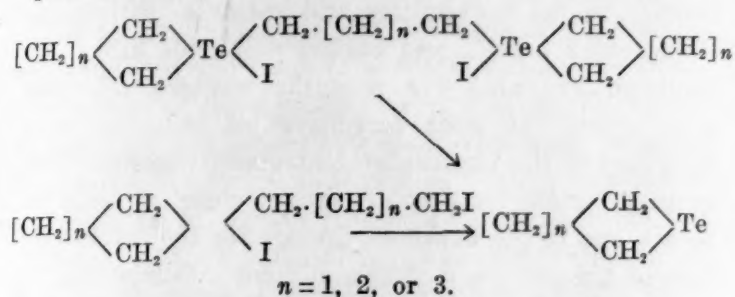
Cyclic systems containing selenium and tellurium: Considerable progress has been made in the study of heterocyclic systems containing selenium or tellurium atoms. The selenium series has been prepared by a general method, the interaction of alkylene bromides and sodium selenide in an inert atmosphere.



In this way the cyclic selenohydrocarbons with $n = 1, 2, 3$ or 4 have been obtained for the first time. The five-membered ring, *cycloselenobutane* (tetrahydro-

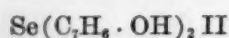
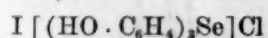
selenophen) and its next homologue, *cycloselenopentane*, are formed by the foregoing reaction with considerable facility, but the four- and seven-membered rings show signs of instability, and in their production complex solid polymerides make their appearance.

In the tellurium series the corresponding cyclic derivatives are conveniently prepared by the action of aluminium telluride on alkylene halides. This process leads to the production of cyclic systems containing quadrivalent tellurium.



From the foregoing complex telluronium iodides the cyclic tellurohydrocarbon is obtained by thermal dissociation under reduced pressure. By such means *cyclotellurobutane* and *cyclotelluropentane* have been isolated and some evidence was obtained of the existence of a four-membered ring.

Aromatic selenium and tellurium compounds: Phenol and the cresols have been condensed with selenium oxychloride when two types of seleniferous products have been distinguished, polar salt-like substances (Formula I) and non-polar selenides (Formula II).



When the cresols were condensed with basic tellurium chloride the following types were distinguished, all containing quadrivalent tellurium: $\text{HO} \cdot \text{C}_7\text{H}_6 \cdot \text{TeCl}_3$, $(\text{HOC}_7\text{H}_6)_2\text{TeCl}_2$, $(\text{HOC}_7\text{H}_6)_3\text{TeCl}$. The more soluble of such selenium and tellurium compounds have been tested on trypanosomes, but so far no evidence of activity has been discerned.

Studies in the Diphenyl Series: The *o*-xenylamine required in the synthesis of cyclic antimonials was formerly obtained in a somewhat tedious manner by the pyrolysis of diazoaminobenzene. This base has now been prepared by a method practicable on a large scale from commercially obtainable diphenyl.

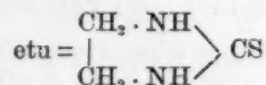
o-Xenylamine and its homologues, for example, 4':5-dimethyl-*o*-xenylamine, are convenient starting-points for the synthesis of carbazole and phenanthridine derivatives.

RESIDUAL AFFINITY AND COORDINATION

An experimental study of the effect of various coordinated addenda on the valencies of copper, silver and gold has been pursued during the past five years with the following results.

Stabilization of the cupric condition: In the absence of suitable addenda the cupric ion is unstable when in combination with less electronegative anions such as iodide, sulphite, thiosulphate, thiocyanate, selenocyanate and hypophosphite, but by coordinating this metallic ion with ethylenediamine ($\text{en} = \text{NH}_2 \cdot [\text{CH}_2]_2 \cdot \text{NH}_2$) stability is thereby conferred on the bivalent condition, and well-defined complex salts of the following types are obtained: $[\text{Cu}, 2\text{en}, 2\text{H}_2\text{O}] \text{I}_2$, $[\text{Cu}, 2\text{en}, \text{R} \cdot \text{OH}] \text{I}_2$ ($\text{R} = \text{CH}_3$ or C_2H_5), $[\text{Cu}, 2\text{en}] \text{X}$ where $\text{X} = \text{SO}_3$, S_2O_3 , S_2O_6 , S_3O_6 or S_4O_6 and $[\text{Cu}, 2\text{en}] \text{Y}_2$ where $\text{Y} = \text{CNS}$, CNSe or H_2PO_2 . Moreover, the following stable normal salts $[\text{Cu}, 2\text{en}] \text{CO}_3$, $2\text{H}_2\text{O}$, and $[\text{Cu}, 2\text{en}] (\text{NO}_2)_2$ are obtainable with carbonate and nitrite radicals respectively.

Stabilization of the cuprous condition: Even more noteworthy than the preceding effect of ethylenediamine is the influence of addenda containing sulphur on the stability of the cuprous ion. Cuprous sulphate, an endothermic compound, decomposes in water with generation of heat and loss of half its copper, $\text{Cu}_2\text{SO}_4 + 5\text{Aq} = \text{CuSO}_4 + 5\text{Aq} + \text{Cu}$, but by coordinating the cuprous ion with ethylenethiocarbamide,



the univalent condition becomes stabilized even in combination with nitrate, sulphate and acetate radicals. The following colorless water-soluble salts have been identified: $[\text{Cu}, 4\text{etu}] \text{NO}_3$, $[\text{Cu}, 3\text{etu}]_2\text{SO}_4$ and $[\text{Cu}, 3\text{etu}] \text{CH}_3\text{CO}_2$.

Coordination compounds of silver: Since the silver ion is generally univalent, its coordination with ethylenethiocarbamide or other sulphur containing addenda does not involve any change of valency. It is, however, significant that $[\text{Ag}, 3\text{etu}] \text{Cl}$ is a water-soluble salt which remains colorless even after prolonged exposure to light.

A contribution to the chemistry of bivalent silver has been made by coordinating its ion with α - α' -dipyridyl (dipy), and the following colored salts have been isolated $[\text{Ag}, 2\text{dipy}] \text{S}_2\text{O}_8$ (chocolate brown), $[\text{Ag}, 2\text{dipy}] (\text{HSO}_4)_2$ (dark brown plates) and $[\text{Ag}, 3\text{dipy}] (\text{ClO}_3)_2$ crystallizing in well-defined, lustrous, black, acicular prisms.

Stabilization of the aurous condition: Coordination of gold salts with ethylenethiocarbamide has the same effect as with copper compounds. The fundamental univalency of the metallic ion becomes stabilized so that the following complex aurous salts have been identified: $[\text{Au}, 2\text{etu}]_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$, $[\text{Au}, 2\text{etu}] \text{NO}_3$, $[\text{Au}, 2\text{etu}] \text{Cl}$, H_2O and $[\text{Au}, 2\text{etu}] \text{Br}$, H_2O . These compounds are colorless and dissolve in water to prac-

tically neutral solutions (P_H value about 6.2). Conductivity experiments indicate that in dilute aqueous solutions these complex salts are highly ionized so that the complex radical $[Au, 2 etu]^1$ plays the part of a compound alkali ion. The bromide of this series was mentioned last year by Professor W. E. Dixon (*loc. cit.*) as being a compound which had the effect of delaying death when administered to animals infected with bovine tuberculosis.

CHEMICAL ENGINEERING

The mainstay of the foregoing investigations are the well-equipped workshops manned by five skilled artisans who are engaged on the production and maintenance of the appliances and plant required in the various research programs. Appliances for high-pressure chemistry are a speciality of the laboratory workshops, and such plant includes bombs and pre-heaters for flow-through experiments with gaseous reagents, and autoclaves of various types for reactions with gases, liquids and solids. The researches on tar products call for automatic extractors, filter plant and stills operating under either ordinary or diminished pressures.

THE STATE LABORATORY AND THE SCIENTIFIC PUBLIC

The twofold primary aim of any state research laboratory should be the collection and dispersal of scientific knowledge and information. For the former function of collection and discovery of new knowledge the exploring parties foreseen by Professor Vernon Harcourt should supply an adequate means providing that each group proceeds under enlightened and inspired leadership. But for the complementary function of dispersal of information a chemical laboratory must depend largely on such well-established media of publication as the journals of the leading chemical societies. The greater part of the published research of the Teddington laboratory has appeared in the journals of the Chemical Society and of the Society of Chemical Industry, although a certain proportion has been published in the Proceedings of the Royal Society, *Journal of the Institute of Metals*, and Proceedings of the Institution of Chemical Engineers. Grateful recognition should be recorded for the generous aid afforded by all these learned societies, and special thanks are due to the first two mentioned. It is my personal opinion that this mode of dispersing chemical knowledge should have priority over its publication in official governmental reports. First, because in this way the information radiates more rapidly to a wider public; thus each of the two chemical journals just mentioned has more than 5,000 registered readers. Secondly, because this form of publication is frequently preceded by a reading and

discussion of the subject-matter at a scientific meeting, and lastly because the financial circumstances of the learned societies compel them to impose a limit on the length of communications which is conducive to brevity and conciseness.

RELATIONS WITH OTHER SCIENTIFIC INSTITUTIONS

Apart from substances of therapeutic interest prepared for the committee on chemotherapy, numerous other research materials have been distributed to colleagues in the universities and research institutions. Compressed helium and carbon monoxide have been rendered available for scientific workers requiring these gases. Organic derivatives of tellurium have been lent to the Cambridge University Chemical Laboratory for the purpose of physico-chemical measurements, and to the Birkbeck College for the demonstration of the parachor of this element. Compounds of special chemical interest have been supplied to the Davy Faraday Laboratory and to the National Physical Laboratory for the X-ray study of their crystal structure. It is a pleasant duty to refer to the aid received from the Government Laboratory in respect of microanalyses and in connection with the work on synthetic resins.

Reference has already been made to the close collaboration of the laboratory with H.M. Fuel Research Station in regard to the products of coal carbonization. Certain preparations from low temperature tar have been submitted to the Cotton and Woollen Research Associations, for examination in connection with the chemical treatment of textile fibers.

RELATIONS WITH CHEMICAL INDUSTRY

The associations of the laboratory with chemical industry have always been cordial and are daily becoming increasingly intimate. Prominent industrialists either individually or in their corporate capacity as members of the Association of British Chemical Manufacturers and allied organizations have visited the laboratory and sometimes repeatedly.

Arising out of these visits and informal conferences, more than a hundred samples of the research products of the laboratory have been distributed to interested enquirers.

Members of the scientific staff participate in the work of the Committee for the Standardization of Tar Products Tests, the Bureau of Chemical Abstracts, the Corrosion Committee of the Iron and Steel Institute, and the Council and various Committees of the Society of Chemical Industry.

Although the laboratory is not a teaching institution in the academic sense of the term, yet facilities have been afforded for collaboration in research to chemists in training of approved qualifications. The

two leading metropolitan gas companies have seconded to the laboratory for this purpose junior members of their scientific staffs who have worked at Teddington for periods ranging from six to eighteen months. The subjects so far selected for this collaboration have been high-pressure chemistry and low temperature tar.

In the foregoing description of the activities of the new laboratory I have endeavored to speak as historian rather than as advocate, but if any justification is to be included I would take as the two leading points of my case: First, the scientific and industrial importance of the researches completed and in progress; secondly, the significant fact that of the sixteen members of the laboratory staff who have resigned during the five years, fourteen have gone into chemical industry to occupy positions of considerable importance and responsibility. The appreciation of chemical talent is a valuable function of this state laboratory.

ANTICIPATIONS AND CURRENT TENDENCIES

Those who feel sufficiently interested in the realization of Professor Vernon Harcourt's vision should not fail to visit the exhibit of laboratory products now on view in an adjacent room, for these specimens, diagrams, models and photographs furnish a record of the researches of this youthful organization which is far more realistic and appealing than any words of mine can be.

Certain of these investigations have an immediate practical objective; others represent the long view. It is, however, impossible to draw a definite distinction between these contrasted types. The aim of a state laboratory should rather be to encourage a judicious blend of the two.

The chemical preparations now selected for exhibition as representing the work of the first five years are only the more distinctive specimens of a much larger collection which is continually being accumulated and classified. In a similar orderly manner chemical knowledge is being collected and systematized in the files and card-indexes compiled by members of each exploring party. So soon as any particular research is sufficiently complete it is contributed to the appropriate learned society. Occasionally publication takes the form of patent specifications. By such concerted efforts the laboratory must come to be recognized as a storehouse of chemical information at least for those branches of the science which are included in the scope of its researches.

Is it desirable that this scope should be extended, and if so in what directions? This is not the occasion to discuss matters of departmental policy, but, in my present capacity, I may, like my predecessor of fifty-five years ago, indulge in anticipations of how

future developments might be of advantage to chemical science in general and to British chemistry in particular.

INORGANIC AND MINERAL CHEMISTRY

An eminent authority has recently enquired what has become of inorganic chemistry and this question is frequently repeated. The present answer is that, so far as this country is concerned, the subject is no longer investigated systematically. British chemists are now for the most part content to leave this work of exploration to their contemporaries in other lands. Yet the British Empire is endowed with mineral resources to an extent unsurpassed by any other nation or empire under the sun. It can scarcely be contended that in this respect we are rendering an adequate account of our stewardship. Although there are a few meritorious exceptions, one may say broadly that there is no sustained British attempt to study the rare earths, the less common alkalis, or the metals of the platinum group. Such chemical curiosities as beryllium, gallium, germanium, indium and thallium rarely excite the scientific interest of our investigators. Yet the chemical study of the less common elements, and especially of those grouped under the disparaging term of "minor metals," is a matter of considerable scientific importance and one which sooner rather than later is likely to yield results of industrial value. If proof of this statement is needed, reference may be made to the inert gases which were first noticed in 1894 and subsequently found by Ramsay and Travers to be five in number. To-day three of these gases are employed industrially.

I have already mentioned low temperature tar which is literally a burning question. The great German combination of chemical factories—the *Interessen Gemeinschaft*—have recently filed patents describing the catalytic effect of molybdic acid on the hydrogenation under pressure of this intractable material. They claim a clear volatile product obtainable in good yield and suitable for motor fuel. Further investigation shows that this beneficial catalytic influence is peculiar to molybdenum compounds and is not possessed by analogous compounds of the other metals of the sixth periodic family. It certainly pays to study chemically the idiosyncrasies of the rarer elements and their derivatives.

THE ORGANIC CHEMISTRY OF VITAL PRODUCTS

At the Bristol meeting of 1898, Professor F. R. Japp's presidential address to this section dealt with the subjects of stereochemistry and vitalism. He called attention to nature's method of preparing single optically active substances, and referred to the insufficiency of the mechanical explanation of vitalistic phenomena.

Considerable advances have since been made in our knowledge of the fundamental process of photosynthesis, notably as the result of suggestive discoveries by Professor Baly and his collaborators, but nevertheless we still have much to learn from nature in regard to the synthesis of carbon compounds. This study of the products of the vital activities of animal and vegetable organisms was the original province of organic chemistry, and to this circumstance the science owes its distinctive name. During the last eighty years, however, organic chemists have extended the scope of enquiry to many substances which are produced not as the result of vital forces, but through the agency of the laboratory arts.

For instance, the organometallic compounds, which have no counterparts in nature, have received intensive study because of their influence on the development of modern chemical theory, their practical application in many operations of organic synthesis and their utilization as drugs, weapons of chemical warfare and antidetonants. No objection can be urged against the continued investigation of such important artificial products providing that naturally occurring organic materials are not overlooked.

Professor Japp's address supplies the philosophic reason for a closer study of the products of vital activity, and at present other more mundane considerations may be adduced in support of such researches.

Political and economic forces are bringing into prominence the urgency for a mutually advantageous interchange of commodities between the constituent nations and colonies of the British Empire, and in this pooling of natural resources organic chemistry must play an essential part. Many of the natural products of the dominions and dependencies are in need of systematic chemical study.

Animal and vegetable fats have been mentioned by an investigator in that field as constituting a neglected chapter of organic chemistry, but the phrase is at least as applicable to many other groups of organic substances, for example: the essential oils, the natural gums and resins, and the numerous products of fermentation processes.

By catalytic reductions, involving high temperatures and pressures, one obtains from the oxides of carbon many members of the homologous series of alcohols, aldehydes, fatty acids and esters. Plant life accomplishes similar results under ordinary atmospheric conditions. A comparative study of these two dissimilar sets of processes is clearly demanded.

The importance of imparting to organic chemistry an increasingly biological bias has been illustrated in a convincing manner by my immediate predecessor, Professor Barger, so that anything more than a passing reference to this desirable tendency is hardly required of me. Perhaps, however, I should add that in stressing the need of more systematic research in inorganic and mineral chemistry and in the organic chemistry of vital products, I am convinced that the best results will only be attained if the problems are attacked with the newest weapons which the armory of modern physics can provide.

The primary object of such investigations is the collection of accurate chemical information, but the workers in these two great fields should be stimulated in every possible way to keep a shrewd lookout for any practical applications of their scientific knowledge. When viewed from this standpoint it will be realized that a state experiment in chemical research such as I have described provides competent and enterprising investigators with favorable opportunities for developing their inventive talent in fundamental work of national value and importance.

OBITUARY

RECENT DEATHS

THE death is announced of Dr. W. Howard Forsyth, assistant professor of dairy husbandry at the Connecticut Agricultural College.

DR. EDWARD L. SPITZER, an attending physician and former president of the Jewish Memorial Hospital in New York, died on September 18 at the age of sixty years.

FREDERICK D. PRATT, engineer of the General Electric Company, who on March 8 sailed from New York with a group of other engineers to supervise the establishing of electrical plants for the Soviet Government in Russia, died on September 20 at Moscow.

CARL A. MEISSNER, metallurgical engineer, who has for twenty-five years been connected with the U. S. Steel Corporation, died on October 13, at the age of seventy-one years.

DR. LEWIS EVANS, collector of and writer on old scientific instruments, founder of the Lewis Evans Collection of Scientific Instruments in the Old Ashmolean Building at the University of Oxford, died on September 25, aged seventy-seven years.

HERBERT E. SOPER, statistician of the School of Hygiene and Tropical Medicine, London, died on September 10.

M. JEAN BRUNHES, who was for sixteen years pro-

fessor of geography at the University of Freiburg, Switzerland, died on August 25, aged sixty-one years.

A CORRESPONDENT writes: Dr. Carl Tigerstedt, professor of physiology of the University of Helsingfors, in an accident while sailing was drowned on June 21. Communications from his widow state that thus far his body has not been found. Professor Tigerstedt had visited America twice, the last time at the International Physiological Congress in August, 1929. The successor to his father, Professor Robert Tigerstedt, he had accomplished a great deal in research in physiology and particularly in nutritional studies in Finland. His loss will be keenly felt by all workers in nutrition.

GIULIO FANO, formerly professor of physiology and head of the faculty of science at the University of Florence and lecturer at the Universities of Madrid and Barcelona, died on September 28 at the age of seventy-four years.

PROFESSOR M. BOGOSLAVSKI, one of the bridge-building engineers of Russia, died at Leningrad on October 8 at the age of seventy-one years. He built the span over the Volga River. In recent years he had been a professor in the Institute of Communications at Leningrad.

DR. AKOS SZALAY, curator of the National Hungarian Museum, has been killed by a landslide while endeavoring to unearth a prehistoric canoe sunk under the embankment of the River Tisza.

MEMORIALS

At the initiative of the Prime Minister of Norway, J. L. Mowinkel, twelve prominent Norwegians recently handed over to Professor Sem Saeland, rector of the University of Oslo, the sum of 100,000 crowns, about \$25,000, for the purchase of "Polhögda," the

home of Fridtjof Nansen at Lysaker, near Oslo, with the adjoining land, amounting to some 20,000 square meters. The donors desire that the property shall be kept as a lasting memorial to Nansen. They do not, however, wish his home to be turned into a museum, but rather to be utilized for the activities in which the explorer was interested, to be a residence and place where those activities can be carried on. The heirs of Nansen, who have already presented to the public his library and other possessions of public interest, have expressed their willingness to make over the estate for the purpose mentioned. Designs have been approved by the Soviet authorities for a monument to Fridtjof Nansen to be erected in Moscow.

Nature calls attention to the hundredth anniversary of the birth of Albert Günther, one of the most distinguished naturalists in England in the second half of the last century and for twenty years keeper of the Department of Zoology in the British Museum. To mark the centenary, his son, Dr. R. T. Günther, of Oxford, has prepared a bibliography of his father's writings, which has been published as a supplementary number of the *Annals and Magazine of Natural History* (August).

THE *Scottish Geographical Magazine* reports that in July last a massive stone cairn carrying a bronze tablet was unveiled at Inchnadamph, Sutherland, as a memorial to the two distinguished Scottish geologists, Benjamin Neeve Peach and John Horne. The tablet bears the following inscription: "To Ben. N. Peach and John Horne, who played the foremost part in unravelling the geological structure of the Northwest Highlands, 1883-1897. An International Tribute, erected 1930." Mr. H. M. Cadell presided at the unveiling ceremony, which was performed by Sir John Flett, director of the Geological Survey of Great Britain.

SCIENTIFIC EVENTS

THE BRITISH GEOLOGICAL MUSEUM

THE British Geological Survey Board reports that excavations preliminary to the construction of the foundations for the new building adjoining the Science Museum in South Kensington have begun.

In the "Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1929," as abstracted in the *London Times*, the director reports that the position in Exhibition Road is ideal for the purpose, being midway between the eastern wing of the Natural History Museum and the new buildings of the Science Museum. With both of these institutions the new Geological Museum is to have direct connection by means

of passages through which the public can travel from one series of galleries to the other. In this way the mineralogical and paleontological galleries of the British Museum and the mining, metallurgical and geophysical galleries of the Science Museum will be in close juxtaposition with the exhibits of stratigraphical geology and economic geology in the Geological Museum, and the combined exhibition will provide a display of objects illustrating the composition and history of the earth's crust that has never hitherto been available in any country.

The work of construction will take at least three years. Although the details of the exterior of the building have not yet been finally settled, it is ex-

pected that the façade will resemble that of the Science Museum in its essential features. The library and offices of the Geological Survey are to be situated at the back of the new museum, with direct access from the exhibition floors and galleries. A large room is to be provided in the library for students, engineers and others who wish to consult geological maps and literature and as the library is in close contact with the science library, the public will find at South Kensington a vast accumulation of periodicals, memoirs and maps on all matters relating to geological science open for immediate reference. The new library will provide abundant space for books and maps, of which the survey has a magnificent collection, and the new offices and laboratories will greatly facilitate research and publication work by the staff.

The space occupied by the new museum is approximately 310 feet long by 105 feet in breadth. The museum in Jermyn-street, which at present does not provide accommodation for the whole of the survey staff, covers an area approximately 12,100 square feet, so that it is less than half as large as the new museum. The exhibition space contains three galleries similar in their general plan to those of the adjacent new wing of the Science Museum. Of these only two will be open to the public, the uppermost gallery being reserved for study and systematic collections to be consulted, especially by research workers. On the ground floor ample space is afforded for exhibits of general geological interest, and the galleries will be devoted to stratigraphy and economic geology.

The survey offices and library, at the back of the new building, occupy about one quarter of the cubic space provided. By this means adequate room will be obtained for the accumulations of geological material for many years, and the reference collections will be in well-lighted galleries accessible both to research workers and to the staff. Laboratory accommodation will be ensured for chemical, optical, petrographical, crystallographic, paleobotanical, geophysical and mineralogical work, which has been sorely needed for many years. It is expected also that certain rooms will be available for research workers who wish to investigate the maps and records or the collections of the survey.

The total floor space is about 135,000 square feet. Of this the survey offices with laboratories and library will occupy 40,000. The exhibition space on the main floor and the first and second galleries is 53,000 square feet. The basement provides 25,000 square feet, which will be used for storage, workshops and accommodation for subordinate staff. The uppermost gallery, reserved for study collections and research, has a floor space of over 16,000 square feet. Of the total floor space about two fifths will be

allotted to exhibition of specimens, and of the remainder about one half will serve as offices, library and laboratories and one half as storage for collections.

THE GREAT SMOKY MOUNTAINS NATIONAL PARK

THE Attorney General has formally passed on the titles of the lands tendered the Department of the Interior by the governors of North Carolina and Tennessee which are to constitute the Great Smoky Mountains National Park. Following this action the land has been formally and finally accepted by the government.

National preservation of at least a portion of the most magnificent mountain scenery in the eastern section of the United States has thus been assured. The area covers 158,876 acres. These lands will form a nucleus for a great park with a minimum area of 427,000 acres. The park may be extended to include over 700,000 acres under the act of the Congress authorizing its establishment. Funds to acquire the minimum acreage are available to the States of North Carolina and Tennessee.

Already plans have been made for transferring from the western parks several men thoroughly trained in national-park work and policies, to undertake the protection and administration of the area now in the possession of the United States. This means primarily guarding the forests against fire and the plants, animals and natural formations against damage or destruction. Later, when the entire minimum area of 427,000 acres has been offered to the United States and accepted by the Secretary of the Interior, it will receive full park status. Then the Great Smoky Mountains National Park will be developed along the lines of those in the West. The necessary living and transportation accommodations will be provided, roads and trails constructed, and every opportunity afforded to enable visitors to get the fullest possible enjoyment and use out of the area, consistent with its preservation in its primitive condition for the use of future generations.

The area of the Great Smokies is a vast, unspoiled, primitive region, with spectacular mountains rising upwards 5,000 feet and more from their base. Particularly impressive are the luxuriant forests which clothe the peaks to their very summits. The park will be divided about equally between Tennessee and North Carolina, one great mountain range carrying the state boundary.

The new park will be a boon to the peoples of the highly developed industrial region of the east. It will be within reach of millions of people who, because of time and distance, are unable to take advantage of the

opportunities for enjoyment afforded by the western national parks.

The Great Smoky Mountains National Park is a ten-million-dollar project. When Congress authorized its establishment, it was with the proviso that all the lands to be included should be donated to the Federal Government. The states, realizing the importance of saving the area in its primitive condition and giving it national status, through their citizens and legislatures subscribed nearly \$5,000,000 toward the desired end. This amount was matched by the Laura Spelman Rockefeller Memorial, in memory of Laura Spelman Rockefeller.

In addition to the Great Smoky Mountains National Park, two other large national park projects have been authorized by the Congress in the east, namely, the Shenandoah National Park in Virginia, and the Mammoth Cave National Park project in Kentucky. Funds for the acquisition of these areas are in the hands of the separate state agencies, and considered sufficient to acquire the land necessary for these parks. At the present time the only national park east of the Mississippi River is the Acadia in the State of Maine. Definite approval of the proposed Tropic Everglades National Park project in Florida also has been given by the Interior Department after an examination by its park experts established the fact that it measured up to high national-park standards.

THE SCOTT FUND EXPEDITION TO MONTANA

THE first discovery of Dinosaur eggs on this continent, found this summer near Red Lodge in southern Montana by the Scott Fund Expedition of Princeton University, is reported by Dr. Glenn L. Jepsen, director of the expedition and instructor in geology at Princeton. A number of the broken remains of the eggs were found. The fragments resemble those found recently in Mongolia in several particulars, both occurring in closely similar geologic formations. The American remains were found in the Upper Lance formation, which was deposited in Upper Cretaceous time, while the Mongolian came from the Djadochta formation, which is also Cretaceous. Since the Mongolian formations are known to be older than the American it is logical to believe that the eggs found this summer are younger than those found in Mongolia.

The broken remains found by the Scott Fund Expedition are rough and pitted. These characteristics belong also to the Mongolian, although the American are black whereas those found in Mongolia are reddish brown. The original eggs were possibly larger than those found in Asia. Since no complete eggs were found this summer, Dr. Jepsen said it is the

plan of the Scott Fund Expedition to return to the same locality at a future date to search for perfect specimens and to excavate for them if that is necessary.

While it is impossible to say what type of Dinosaur laid the eggs, they were found in close association with bones and teeth of the reptile genus *Triceratops*, which may be a descendant of the genus *Protoceratops* found in Mongolia.

Another find in close proximity to the egg fragments was the tooth of a new type of primitive mammal. The importance of this discovery, Dr. Jepsen explained, is that mammal remains found in formations of Cretaceous time are extremely rare. While the affinities and classification of the mammal tooth have not as yet been fully determined, Dr. Jepsen said that it may belong to the order *Marsupialia* and that although it is small it is larger than the few teeth which have previously been discovered in the Upper Lance formation.

The original problem on which the Scott Fund Expedition was working this summer was to discover the upper and lower boundaries in southern Montana of the Fort Union formation which lies on top of the Lance. In connection with the work of determining the upper boundary of the Fort Union formation, a large jaw was discovered which is believed to be a primitive species of *Coryphodon*, or one of its ancestors. The jaw is twelve inches long and has seven teeth, the front one being large and tusk-like. Early in the summer a large number of small jaws were found which will be added to the museum at Princeton and also used for research work. Some belonged to primitive primate-like animals about the size of a very small monkey. Others are what may prove to be the earliest ancestors of the *Artiodactyls*. This group includes the present-day cattle, hogs, sheep, antelope, camels and other well-known animals.

In addition to Dr. Jepsen, the party included Maurice Black, Commonwealth Fund Fellow of Trinity College, Cambridge, England; Kenneth Ridgeway, of Hempstead, L. I., and Edwin J. Moles, Jr., of Minneapolis, both seniors in the department of geology at Princeton University.

THE GEORGE FISHER BAKER NON-RESIDENT LECTURESHIP IN CHEMISTRY AT CORNELL UNIVERSITY

THE George Fisher Baker non-resident lecturer at Cornell University for the present term is Dr. Georg Hevesy, professor of physical chemistry in the University of Freiburg, Germany. Professor Hevesy is a Hungarian by birth, having been born in Budapest in 1885. He first attended the University of Budapest, then the Technische Hochschule of Berlin

and later the University of Freiburg, where he received the degree of doctor of philosophy in 1908. After two years as assistant in the Technische Hochschule of Zurich, he carried on advanced research at Karlsruhe in Professor Haber's laboratory in 1910, and from 1911 to 1914 he held a research fellowship in the University of Manchester, working in the laboratory of Sir Ernest Rutherford. During this period he also carried on research work at the University of Liverpool in the laboratory of Professor Donnan.

He was then called to a position in the Radium Institute of Vienna, and in 1920 he became a member of Bohr's Institute of Theoretical Physics at Copenhagen. In 1926 he was called to the professorship of physical chemistry at the University of Freiburg. While connected with Bohr's institute he carried out, in cooperation with Dr. Coster, of Holland, a brilliant research that led to the discovery of the new element hafnium.

A correspondent writes: "The many and diverse investigations of Professor Hevesy have lain in the fields of inorganic chemistry, physical chemistry, electrochemistry, radioactivity and the separation of isotopes, and his researches are characterized by brilliancy of conception, unique experimental attack and convincing thoroughness."

During the coming term Professor Hevesy will lecture on five different topics, as follows: "Chemical Analysis by X-rays and its Applications," "Rare Earth Elements and Atomic Structure," "Chemistry of Hafnium," "Electrolytical Conduction and Diffusion in Solids," "Separation of Isotopes."

SCIENTIFIC NOTES AND NEWS

JEWISH residents of Montevideo have taken up a popular subscription to present a statue of Professor Albert Einstein to the city on the occasion of Uruguay's centenary of independence. The statue will be erected in one of the most prominent plazas of the city.

SIR ARTHUR STANLEY EDDINGTON on September 25 received the honorary freedom of the town of Kendal, Westmoreland, England, his birthplace. In handing him a scroll recording the decision of the Town Council, the Mayor said: "Kendal is determined it will not leave the recognition of its most distinguished sons to a future generation." It was pointed out in an appreciation sent by Sir Oliver Lodge that it was in Kendal that John Dalton, as first assistant master of a school, began his scientific work.

ABBÉ HENRI BROUIL, professor in the Institut de Paleontologie Humaine, Paris; Sir Arthur Keith, of the Royal College of Surgeons, London, and Professor Grafton Elliot Smith, of University College, London, have been elected corresponding members of the Field Museum of Natural History in recognition of services rendered to the museum.

DR. T. WAYLAND VAUGHAN, director of the Scripps Institution of Oceanography of the University of California, was at the meeting in Eugene, Oregon, elected president of the Pacific Division of the American Association for the Advancement of Science for the year 1930-31.

MR. CHARLES G. DAWES, ambassador to England, has accepted appointment as the delegate of the National Geographic Society to the one hundredth anniversary celebration of the Royal Geographical Society, London, on October 21. Mr. Dawes is a member of the board of trustees of the National Geographic Society.

PROFESSOR FRANCIS G. BENEDICT, director of the Nutrition Laboratory of the Carnegie Institution of Washington, was the guest of honor on October 3 at a dinner given for him by friends and associates at the Algonquin Club, Boston, to celebrate his sixtieth birthday. Professor George H. Parker presided, and the speakers were Dr. Elliott P. Joslin, Dr. Eugene F. DuBois, Dr. George W. Crile, Dr. Allan Winter Rowe and Professor Benedict.

DR. OTTO OLDENBERG, professor of physics in the University of Göttingen, has accepted a call to Harvard University. Professor Oldenberg lectured at Harvard University last year.

PROFESSOR EDGAR T. WHERRY has resigned from the position of principal chemist in charge of the crop chemistry laboratory, Bureau of Chemistry and Soils, to become associate professor of plant ecology in the department of botany of the University of Pennsylvania.

DR. ALEXANDER GOETZ, of the University of Göttingen, has been called to an associate professorship of electrophysics in the California Institute of Technology.

At a recent meeting of the agricultural council of the Board of Trustees of Cornell University, Dr. D. C. Carpenter was named head of the division of chemistry of the State Agricultural Experiment Station at Geneva, New York. Dr. Carpenter has been engaged for the past several years in researches on casein both at Geneva and at the University of Upsala, Sweden. At the same time the council promoted Leon R. Streeter from associate in research to be chief in research, and Dr. Z. I. Kertesz from assistant in research to associate in research in chemistry. The appointment of Dr. J. J. Kereura, formerly of the

Ohio State University, to be an assistant in research in chemistry on the station staff is also announced.

It is reported by the Department of Commerce in Washington that Mr. E. B. Swanson has been appointed chief economist of the division of petroleum economics of the United States Bureau of Mines. Mr. Swanson has been serving as acting chief of the division since October, 1928. Other recent personnel changes in the petroleum economics division included the promotion of G. R. Hopkins from associate petroleum economist to economic analyst and of A. H. Redfield from assistant scientist to associate economic analyst.

DR. ADDAMS S. MCALLISTER has been appointed assistant director in charge of commercial standardization in the Bureau of Standards. The appointment of Dr. McAllister fills a vacancy created by the resignation of Mr. R. M. Hudson on December 31 of last year.

MR. H. W. DICKINSON, senior keeper in the Science Museum, South Kensington, England, retired on September 1.

PROFESSOR G. E. MACGINITIE has been appointed acting director of the Hopkins Marine Station of Stanford University for the autumn quarter during the absence of Dr. W. K. Fisher.

MAJOR JAMES STEVENS SIMMONS, who for the past two years has been president of the Army Medical Department Research Board at the Bureau of Science, Manila, has been assigned to the staff of the Army Medical School, Washington, as instructor in charge of the bacteriological department.

DR. FERDINAND W. HAASIS recently resigned his position as associate professor of forestry at the University of Idaho to become research associate of the Carnegie Institution of Washington. He is working with Dr. D. T. MacDougal at the Coastal Laboratory of the Division of Plant Biology, Carmel, California.

PROFESSOR R. B. THOMSON, professor of anatomy and head of the Department of Botany of the University of Toronto, has been granted leave of absence for the collegiate year 1930-31, because of ill health. Dr. H. S. Jackson, professor of mycology, has been appointed acting head of the department during Professor Thomson's absence.

DR. OSCAR RIDDLE, of the Carnegie Institution, Cold Spring Harbor, returned to New York on October 2 from a visit to various laboratories in Europe. He served as chairman of the American delegation at the International Congress for Sex Research, London, and as a vice-president at the International Congress of Zoologists, Padua.

THE Tulane University medical expedition to Central America to study the relationship of tropical diseases to men and monkeys, under the direction of Dr. E. C. Faust, has returned from visiting the jungles of the Canal Zone.

A DETAILED survey of the city of Rio de Janeiro and environs with a study of inland waters is to be undertaken by Dr. Preston James, professor of geography at the University of Michigan.

DR. HUGH M. SMITH, who has been in Siam for several years establishing a department of fisheries for the Siamese government, is on a vacation in the United States for several months. While in Siam he has been making a collection of birds and other natural history objects in his spare time and has already presented several thousand birds to the National Museum, with another large shipment on the way, chiefly from the mountains of northern Siam and localities on the eastern border of that country, where little natural history work has been carried on.

THE department of chemistry of the Pennsylvania State College, in cooperation with the department of electrical engineering, announces that the fifth annual Priestley Lectures will be given by Dr. John W. Williams, assistant professor of chemistry of the University of Wisconsin, on November 10, 11, 12, 13 and 14, at 7 P. M. The general subject of the lectures will be "The Relation between Physical Chemistry and Electrical Engineering."

THE twenty-third Hanna Lecture was delivered at the School of Medicine, Western Reserve University, on September 25 by Professor Franz Knoop, professor of physiological chemistry at the University of Tübingen, on "The Significance of the Intermediary Metabolism." On September 26 he gave a second lecture in which he presented an informal review of his work on beta-oxidation.

THE Harben Lectures for 1930 were delivered on October 6, 7 and 8 at the Royal Institute of Public Health, London, by Professor William H. Park, director of the Bureau of Laboratories, Health Department, New York City.

THE British Science Guild announces that the sixth annual Norman Lockyer Lecture will be delivered by Professor Sir William Pope, on November 13.

THE Harveian Oration will be delivered before the Royal College of Physicians of London on October 18 by Professor John Beresford Leathes, F.R.S.

THE American Astronomical Society will hold its forty-fifth meeting in New Haven. The date of the meeting has not been set definitely but it will probably be the latter part of the week December 28 to January 3.

THE Ninth Annual Exposition of Power and Mechanical Engineering is to be held from December 1 to 6 in the Grand Central Palace, New York, N. Y., under the leadership of I. E. Moulthrop, chairman of the advisory committee of the exposition. This year plans call for an exhibit which will include many indications of progress during the year which has already seen numerous mechanical advances.

THE Seventeenth French Congress of Hygiene will be held at the Institut Pasteur, Paris, under the presidency of Professor Delépine, of the Académie de Médecine, from October 20 to 23, it is announced in the *British Medical Journal*. The following subjects will be discussed: the successive changes in the French pharmacopoeias, introduced by the president; comparative statistics of infantile mortality, introduced by Dr. Lesage; the relation of health offices to health inspection, introduced by MM. Aublant and Prunet, and Brocquin-Lacombe and Bennet; and hygiene and reconstruction in the flooded area in the south of France. Lectures will also be delivered by Professor Sacquépée on psittacosis, and by Dr. Dujarrie de la Rivière on Lavoisier as hygienist. Further information can be obtained from Dr. Dujarrie de la Rivière, Institut Pasteur, Rue Dutot, Paris, XV^e.

MR. EDWARD S. HARKNESS has given to Columbia University \$500,000 to supplement his original gift of \$2,000,000 for a residence hall at the Medical Center.

AN exposition, the object of which will be to demonstrate the general health conditions and progress in physical culture in Switzerland, will be held in Berne next year. The exposition will be divided into groups, as follows: Climatic; climatic and bathing resorts; housing; architecture, popular dwellings, unhealthy houses and quarters, heating systems, cleaning, ventilation, disposal of refuse, drinkable water: food; meat and its food value, unhealthy meat, animal diseases, milk and milk products, frauds and unsanitary handling of food products, sanitary maintenance of stables, vegetables' nutritive value, falsifications: fashions and clothing; history of clothing, methods of examining tissues and colors, irrational and eccentric clothing, industry and trade. Corporal hygiene and sports; physiological effects of hygiene, bathing and baths, sport societies and establishments: labor; protection of workers, safeguards and insurance: infectious diseases; campaigns against epidemics, vermin and parasites: care of sick and ailing; hospitals, clinics, polyclinics, dispensaries, training schools for nurses, National Red Cross. Scientific and medical research; goiter, cancer, intoxication, alcoholism, origin, preparation and use of medicines: child welfare; traffic; sanitary installations, traffic rules, antidust campaign: man; anatomy and physiology, medical and natural science history, racial hygiene and heredity. Statistics; statistics pertaining to hygienic and medical facts: sanitary service of the army: industries and trade; general review of present sanitary and hygienic conditions and facilities.

DISCUSSION

YARDANG AND ZASTRUGA

USING the right term in the right place is like choosing the proper tool for a particular operation in carpentry. Both facilitate good work. Hence this note regarding two terms useful to geologists but somewhat confused in usage and not yet widely employed.

The words *yardang* and *zastruga* denote certain features made by the action of the wind. The first is a native Asiatic word utilized by the explorer Sven Hedin¹ to name the curved and often undercut ridges that the sandblast carves from weakly indurated deposits of silt and sand. Such forms are found in all deserts. The German spelling used by Hedin is "jardang" but the Anglicized form is preferable for English-speaking workers.

Zastrugi (singular *zastruga*) are wind-made ridges of snow, well known to polar explorers and to dwellers in cold regions in general. The Russian word

zastruga means a splinter made by planing a board against the grain.² From that it was modified to designate a sand bank undercut by a stream and also mere sand bars built by currents. In Siberia it came to be used for the low ridges, most of them sharply undercut on the windward side, that are characteristic of snow surfaces abraded by strong winds. The first use of the term in scientific writings, so far as the writer has been able to learn, was in a geographical report by Baron von Wrangel³ who thus referred to the wavy ridges on the snow in the Arctic wilderness. In transliterating into German, the Russian *zastruga* became *sastruga*, and the latter spelling has unfortunately been adopted by most later English and American writers. The Century Dictionary, however, gives only the original and correct form, *zastruga*.

Snow, sand and silt are all mineral deposits of sim-

² Vladimir Dal, "Explanatory Dictionary of the Russian Language," Vol. I, p. 661, 1880.

³ Baron Ferdinand P. v. Wrangel, "Journey along the North Coast of Siberia," pp. 311-312, 1839.

¹ Sven Hedin, "Central Asia and Tibet; towards the Holy City of Lassa," Vol. I, p. 365, 1903.

ilar grain and consistency. The action of the wind upon them forms almost identical features, some by erosion and others by heaping up the material swept from elsewhere. In view of these facts it seems at first glance that one term for the eroded ridges and another for the built features would suffice. We might then have silt *zastrugi* and snow *zastrugi* and also sand dunes and snow dunes. Out of 28 geologists and explorers to whom I have referred the question seven adopted this position, while two made no choice.

Of the fourteen who believe that both *zastruga* (or less correctly *sastruga*) and *yardang* are needed terms and should be retained, some are influenced by the fact that snow differs from silt in being subject to melting. Others, including three Arctic explorers and two eminent geomorphologists, employ the word *zastrugi* to denote the various minor irregularities of the snow surface whether due to erosion, deposition or differential melting.

The *yardang* is apparently a definite type of land form due exclusively to the abrasive action of wind on suitable material. If any one chooses to speak of *snow yardangs* he will be perfectly understood, as he will be also in speaking of *snow dunes*, *snowslides* and *snow ripples*. The term *zastrugi*, however, has never been thus limited, and it is evidently in common use by Arctic explorers to describe features some of which are wind carved, others wind built and some not wind made at all. From these facts it may be concluded that both terms probably have their uses and will be retained, but of the two *yardang* is the more definitely limited in meaning and hence more satisfactory for the purposes of the careful geomorphologist. *Zastruga* is likely to be used chiefly by Arctic explorers and geographers not primarily concerned with processes of land sculpture.

ELIOT BLACKWELDER

STANFORD UNIVERSITY

WHAT IS CHITINE?

THE entomologists and the chemists have come to a curious dilemma with reference to this very common word. The entomologists universally give it a physical interpretation, using it to refer to the characteristic system of organic substances which make up the insect exoskeleton, while the chemists as consistently use it of a single chemical compound, which they can isolate by the proper chemical processes from this complex. Many people have assumed that the difference was trivial, on the ground that the chemists' "chitin" was the principal substance of the entomologists' "chitin." In fact, Campbell's recent study¹

shows plainly that the chemists' chitin is in fact a secondary constituent of the insect skeleton, never constituting more than half of its substance, and occasionally (as in egg-shells and tracheal lining) wholly wanting.

On turning to the original proposal of the term,² we find that the author undoubtedly was the originator of the misconception that his chitine was the principal substance, on account of the somewhat loose way in which he presents his analysis; but that he obviously had specially in mind the substance that the chemists now call chitin (or rather chitosan), and that he postponed for a later study, which I believe never was carried out, the study of the larger amount of substance which he calls "the part of the precipitate insoluble in alcohol" on page 33, and which obviously includes the substance or substances which give the insect exoskeleton its hardness, its color and the major half of its substance.

Shall entomologists then continue to call "chitine" the substances that make the exoskeleton of insects, as they have been doing for nearly a century, since Newport, or shall they grant to the chemists a word which was originally proposed by a chemist and has had an even longer period of use in chemistry, though there is an older name (*fungine*) for the same substance? I suspect that we shall probably go on as we have been doing; the entomologists will use chitine (like bone) for a physical system of substances which is formed into structures of interest to them; while the chemists will continue to use it of the soft transparent "filler" of the insect skeleton which is on the whole of very little interest to the entomologist, but is a chemical substance of known composition.

There seems need for further research on both sides; the composition of the substances which give the insect skeleton its hardness and its characteristic tint has never been made out—a thing which only the chemists can do; and there is need for the entomologist in turn to find what place in the insect economy is taken by this other substance the chemist calls chitin, and which so commonly makes up a substantial proportion of the skeleton.

WM. T. M. FORBES

CORNELL UNIVERSITY

TOPOGRAPHIC CONTROL OF CLOUD DISTRIBUTION

IN Giles and Montgomery Counties, Virginia, and the adjacent portion of West Virginia, there are three minor physiographic provinces, the state line separating the northwestern from the central. The Cumberland plateau, the northwestern province, is made up of round and oblong hills which rise to

¹ *Annals Ent. Soc. Am.*, 22: 401-426, 1929.

² Odier, *Mém. Soc. Hist. Nat. Paris*, 1: 29-43, 1823.

heights of 1,000 feet above drainage. The Central or Alleghany province is composed of linear ridges separated by valleys of varying width, trending north-east-southwest, with seven more or less definite parallel ridges in a distance of 14 miles rising to heights of 1,000 to 2,000 feet above drainage. The southeastern, or Great Valley province, is a broad valley consisting of a dissected peneplain which lies at an elevation of about 2,100 feet.

It sometimes happens in this region that the alignment of clouds with mountain ridges is so conspicuous that there can be little question but that the distribution of clouds is determined by the topography. This is likely to be conspicuous when there are continuous thin clouds covering the Cumberland plateau and moving to the southeastward. As the cloud mass moves over the Alleghany province there is a gradual alignment of clouds in the northeast-southwest direction paralleling the mountain ridges, separated by narrow cloudless areas, and the perfection of this arrangement increases with progress southeastward across the ridges. This parallelism is maintained for several miles over the Great Valley and gradually becomes less definite.

R. J. HOLDEN

TWIN SEEDLINGS IN ANGIOSPERMS

IN SCIENCE for May 16, 1930, one of the items of the Supplement page xiv has to do with the possibility of two plants being produced from a single seed. "Mrs. Tema Shults Clare, a teaching fellow at the University of Southern California, has obtained in two instances pairs of twin seedlings sprouting from Torrey pine seeds, and one pair of similar twins from the seed of a piñon pine." To this report is added the following statement: "This habit of twinning from single seeds is peculiar to the gymnosperms. The higher seed plants, the producers of showy flowers, apparently do not have this possibility."

In SCIENCE for August 23, 1929, R. H. Woodworth reported the production of two embryos from one seed of *Alnus rugosa*, a species of the Betulaceae which is

a family of the Angiospermae. From a sowing of 150 seeds about 50 per cent. germinated and six of these produced twin seedlings. The pairs have developed quite normally into young plants. This phenomenon is considered at length in a paper entitled "Parthenogenesis and Polyembryony in *Alnus rugosa*," which appeared in the *Botanical Gazette* for June, 1930.

It is also well known that the citrus fruits, particularly the grapefruit, produce seeds which frequently give rise to more than one seedling.

ROBERT H. WOODWORTH

BOTANIC GARDEN,
HARVARD UNIVERSITY

MINERAL RESOURCES OF GREECE

ONE usually thinks of Greece as the home of decaying monuments to immortal thinkers and writers. Few of us realize that Greece is a wealthy country. The ancient Greeks did considerable mining of copper, silver and tin, but they did not begin to touch the wealth of other minerals which lay beneath the soil. The development of natural resources has remained inactive for ages.

The Germans were pioneers in extracting some of Greece's mineral wealth and are still active in some localities. The British have long been quarrying the valuable and extensive marble deposits, but on the whole a vast and virgin area remains to be worked.

The more abundant ores found in Greece are those of iron, lead, sulfur and magnesium. The yearly production of these ores averages 322,000 tons. Iron ore mined amounts to 88,000 tons containing 42-62 per cent. iron. Lead is mined to the extent of 76,000 tons. This ore is rich in silver. Magnesite occurs throughout Macedonia and contains 95 per cent. magnesium carbonate. Other ores extracted in lesser amounts are those of zinc, nickel, chromium, manganese, aluminum, copper and antimony. The total amount mined approaches 30,000 tons yearly.

MAURICE H. BIGELOW

UNIVERSITY OF PITTSBURGH

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PRACTICAL METHOD OF DETERMINING THE FALL IN POTENTIAL IN A MICRO-ELECTROPHORESIS CELL¹

A PRACTICAL method of determining the fall in potential in a micro-electrophoresis cell is described, whereby it is possible to determine the fall in potential at any stage of an experiment without any loss of time.

¹ From the Laboratory of Hygiene, Department of Pensions and National Health, Ottawa, Canada.

The method is a so-called null method and in principle consists of balancing two unknown circuits using a precision voltmeter to register the voltage in one circuit necessary to balance the other, as indicated by a sensitive galvanometer. A certain definite assembly of apparatus was found to be most satisfactory. Fig. 1 indicates the apparatus used together with the connections, and is self-explanatory. The Central Scientific (Weston) galvanometer is placed in the circuit for preliminary balancing.

DIAGRAM OF CONNECTIONS FOR CATAPHORESIS APPARATUS

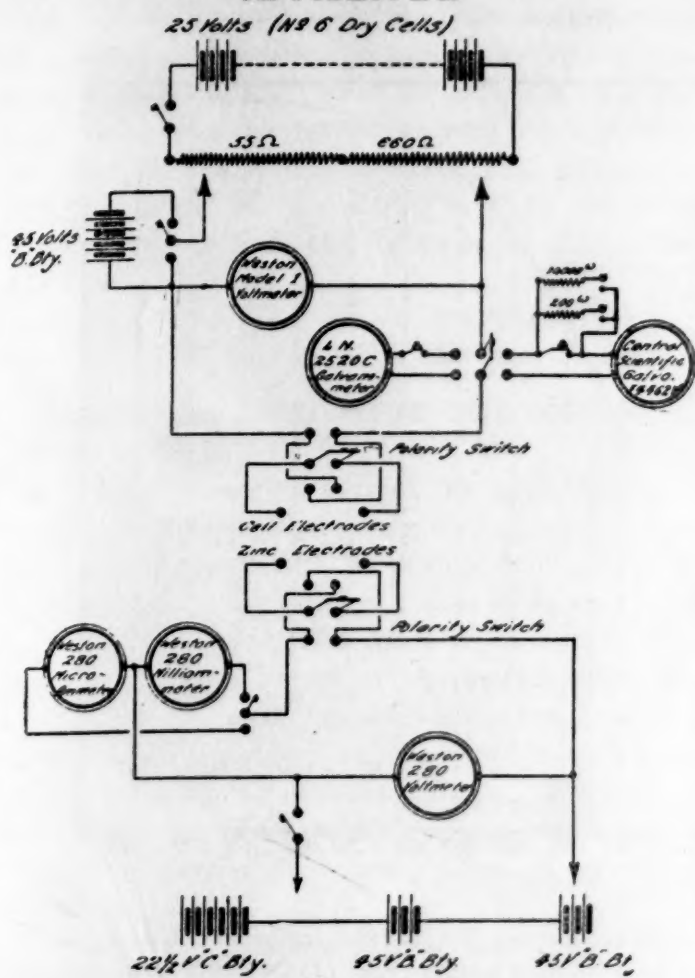


FIG. 1

Polarization may take place if any appreciable current is drawn from the cell electrodes. It is therefore advisable when balancing a circuit not to depress the key switches longer than is necessary to cause deflection of the galvanometer. After a little experience this difficulty is never encountered.

The method and apparatus herein described have been used for several months with a Northrup-Kunitz design of cataphoresis apparatus, and has proved to

be of distinct value in controlling experimental work.

The author wishes to express his appreciation of the advice and assistance given by Captain R. A. H. Galbraith, of the Royal Canadian Corps of Signals.

JAS. GIBBARD

THE MEASUREMENT OF ARM GIRTH

FRANZEN has emphasized arm girth and calf girth in measures of growth and nutrition.¹ The instrument in common use for obtaining these measures is a tape wound about a coiled spring in a small metal case. To keep the tension more or less constant in measurements, a handle is provided with a spring to balance the spring of the case.

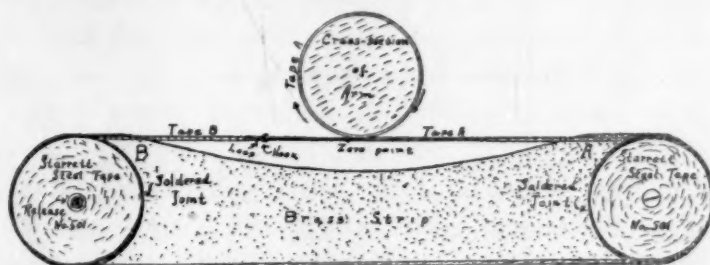


FIG. 1

The figure printed herewith is a drawing to illustrate a method of mounting two steel tapes so that the tension of one may be balanced by that of the other.² When one tape has been looped around the member to be measured, it is attached to the end of the other and both springs are released by the pressure of the thumb of one hand and a finger of the other. Tension is thus controlled automatically. The instrument, which may be called a girthometer, is entirely practicable, having been used for measuring thousands of arm girths under the direction of the writer.

H. T. MANUEL

UNIVERSITY OF TEXAS

SPECIAL ARTICLES

THE LOGISTIC CURVE AND THE CENSUS COUNT OF 1930¹

EARLY in 1920 we published² the results of fitting a logistic curve to the census counts of the population of the United States from 1790 to 1910, inclusive. At the time the computations were made in 1919 the results of the census of 1920 were not available, and

¹ From the Department of Biology and the Department of Biostatistics (Paper No. 153), of the School of Hygiene and Public Health of the Johns Hopkins University.

² Rearl, R., and L. J. Reed, "On the Rate of Growth of the Population of the United States since 1790 and Its Mathematical Representation," *Proc. Nat. Acad. Sci.*, Vol. 6, pp. 275-288, 1920.

therefore were not and could not be included in the calculations. Soon after the original paper was published the notation was improved, and the curve took the definitive form, still, however, *without* the use of the 1920 count,

$$y = \frac{197.27}{1 + 67.32e^{-0.0313x}} \quad (i)$$

¹ R. Franzen, "Physical Measures of Growth and Nutrition," American Child Health Association, 1929.

² The writer was assisted in making the first of these instruments by Mr. Wm. Sachs. While no complete check of the literature has been made, nothing like it has been found in the references consulted. The instrument was devised for use in a study financed by the University of Texas Fund for Research in the Social Sciences.

where y denotes calculated population in millions, and x time, in base units of one year.

A basic implication of the logistic theory of popula-

await the passage of time and the course of events to furnish an impartial judgment regarding its validity and usefulness.

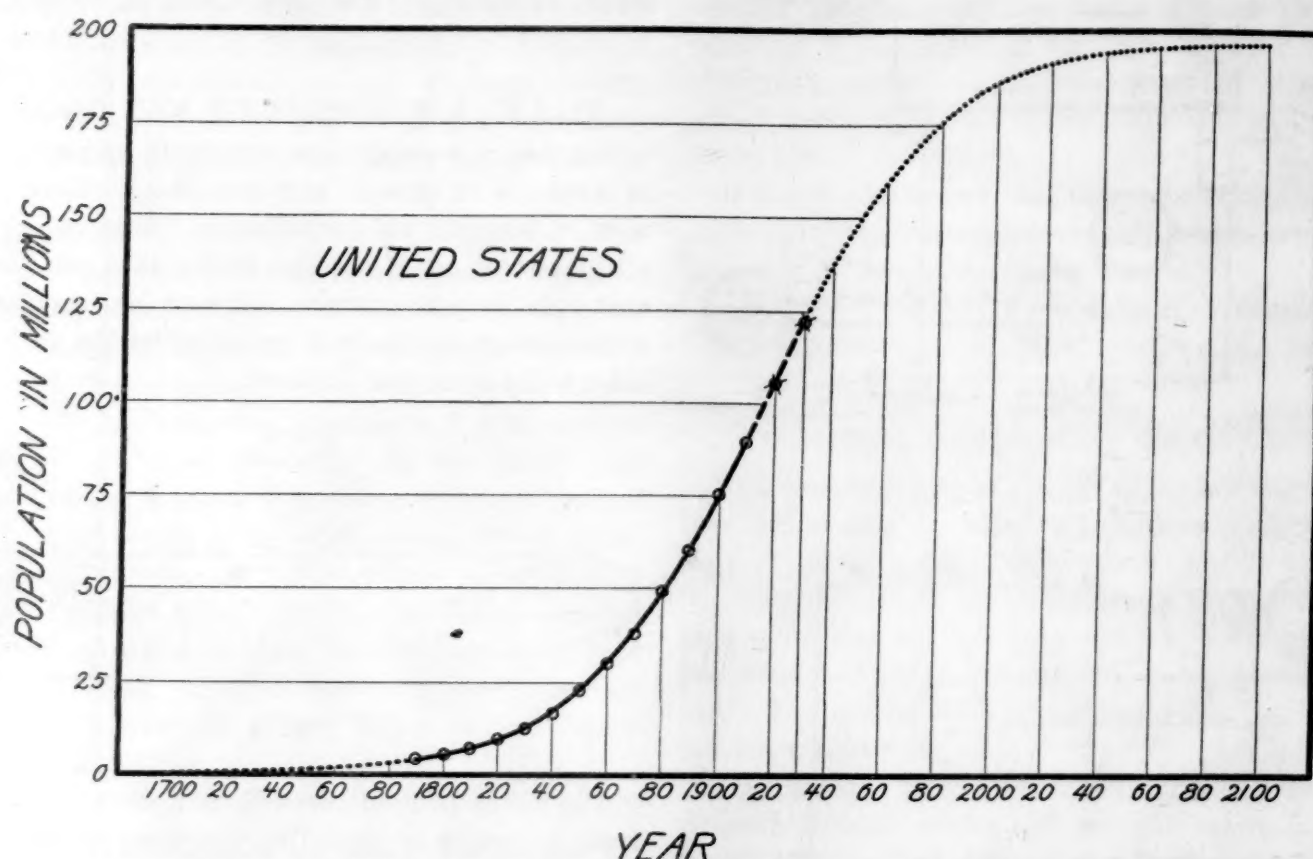


FIG. 1. The census counts of the population of the United States from 1790 to 1930, inclusive (given by circles). The smooth curve is the logistic of equation (i) above fitted to the census counts from 1790 to 1910 inclusive. The broken lines show the extrapolation of the curve beyond the data to which it was fitted. The dash portion from 1910 to 1930 is the part of the extrapolation which has been tested by census counts (crossed circles) which have been made since the logistic was originally fitted. The dotted line shows the further extrapolation of the same curve.

tion growth is that such growth proceeds in an orderly manner according to some law, to which the logistic curve may be taken as a first approximation, so long as the conditions under which the population is growing are not seriously or suddenly altered. Without any thought of implying the possession of any knowledge as to whether, or when, or by how much, the conditions under which the population of the United States had grown between 1790 and 1910 might change subsequent to 1910, we did, as a matter of interest, in our original publication discuss the extrapolation to the year 2100 of the equation given above. At that date this particular curve will be very close to its asymptote of 197.27 million. This logistic curve has not lacked attention in many places and from various persons. It has, in fact, been much discussed, sometimes with approval and sometimes with disapproval. Throughout the mild tempest which has raged about the logistic theory of population growth during the past decade the authors of this paper have refrained from altering the logistic equation for the United States from its original form reprinted above, having seen no reason to do so, and being content to

Twenty years have elapsed since the last *datum* (the census count of 1910) available when the curve was calculated. It seems justifiable now to make some examination of how the case goes. The following little tabulation, and Fig. 1, give the facts.

Population of Continental United States
(in millions)

	A. As forecast by logistic equation (i) (data of 1790-1910)	B. As counted by the Census Bureau
1920.....	107.4	105.7
1930.....	122.4	122.7

It thus appears that the forecast of the logistic curve (equation (i)) missed the counted population by 16 *parts in a thousand* in excess in 1920, and by 2.5 *parts in a thousand* in defect in 1930.

In conclusion, we wish again to emphasize, as we have repeatedly in the past, that it is a basic postulate of the logistic theory of population growth that any particular population can be expected to continue

to follow in its later growth the same logistic curve which it has followed in its earlier growth *only* if there has been no serious or cataclysmic alteration of the conditions (climatic, geological, biological, economic or social) under which its earlier growth has taken place. The present evidence indicates that the population of the United States during the period 1910-1930 continued in its growth along the same logistic curve that it had followed in the period 1790-1910.

RAYMOND PEARL
LOWELL J. REED

LIGNIN AS A POSSIBLE FACTOR IN LODGING OF CEREALS

LODGING is the laying over of the cereal plants at a period when their vegetative growth is nearly completed. It interferes with the normal development of the grain, frequently causing a loss of from five to ten bushels per acre.¹ The accepted opinion is that lodging is generally caused by nitrogenous overnutrition, as it occurs most frequently on naturally fertile soils rich in humus and on soils heavily fertilized with manure or inorganic nitrogen carriers. Lodging is consequently more of a problem under conditions of intensive cultivation than under those of extensive cultivation.

The immediate causes of lodging have been a matter of controversy for more than a century. Sir Humphry Davy² in 1798 associated lodging with a low silica content of the straw, although, as was characteristic of his time, his views were based largely on speculation. In 1842 Liebig,³ the "father of agricultural chemistry," also attributed lodging to a deficiency in silica. His views were supported by a number of investigators but were opposed by the pioneer plant physiologist Sachs⁴ and others. In 1900 Swiecicki,⁵ after a thorough analysis of the opposing views of Liebig and Sachs and their respective followers and on the basis of his own experiments, upheld the view that lodging is caused by a deficiency in the silica content of the straw. He found that the silica content was invariably lower in lodged oats and barley than in normal crops of these cereals grown under comparable conditions. More

¹ F. A. Welton, "Lodging in Oats and Wheat," *Bot. Gaz.*, 85: 121, 1928.

² Davy, "Elements of Agr. Chemistry," p. 51, 1813.

³ Liebig, "Die Chemie in ihrer Anwendung auf Agri-culturechemie und Physiologie," 1 Theil, "Ernährung der Vegetabilien," p. 168, 1862.

⁴ Sachs, "Experimental-Physiologie der Pflanzen," p. 150, 1865.

⁵ Vitold von Swiecicki, "Die Anwendung der Kieselsäure als Bestandteil der Pflanzen und ihre Beziehung zum Lagern des Getreides," *Berichte aus dem Physiologischen Laboratorium und Versuchsanstalt des Landwirtschaftlichen Instituts der Universität Halle*, p. 66, 1900.

recently Headden⁶ and Davidson and LeClere⁷ found that the application of sodium nitrate, which frequently causes lodging, depressed appreciably the ash and silica content of wheat straw. In view of all this evidence pointing toward silica deficiency as a possible factor in lodging, it is remarkable that Welton,¹ who recently made an extensive investigation of the causes of lodging, did not deem it necessary to include ash and silica in the analytical examination of his materials.

Another factor which is considered as one of the causes of lodging is a deficiency in the lignin content of the plants.^{1,4} It has been assumed that lignin lends mechanical support to the stalks, thus preventing them from falling over. The Bureau of Chemistry and Soils has undertaken to ascertain whether or not lignin is a factor involved in lodging of cereals.

Two wheat plots, about 1/50 acre each, were selected in the same field on the Arlington Experimental Farm. One received no fertilizer treatment and served as a control; the other received early in spring sodium nitrate at the rate of 600 pounds per acre, obviously a high application for wheat. The wheat on the fertilized plot grew luxuriantly but suffered from characteristic lodging close to the "milk" stage of the grain. That on the control plot remained erect until harvested. Samples cut from the two plots at frequent intervals up to maturity were analyzed for total ash, silica and other ash constituents, and lignin.

The results, which will be published in full elsewhere, corroborate those of Swiecicki and of Davidson and LeClere mentioned above. The silica and ash content in the straw from the fertilized-lodged plot was in every case lower than from the control plot.

What came as a surprise, however, was that, contrary to the views of Sachs and of Welton, the lignin content of the straw from the fertilized-lodged plot was distinctly higher in every case than of that from the control plot. Accordingly, should the cause of lodging be sought in lignin-content variations between the lodged and erect plants, the conclusion would have to be reached that a high and not a low lignin content is the cause of lodging. This is in accord with the recent work of Dadswell and Hawley,⁸ who found that brash specimens of Douglas fir contained a higher lignin content than tough specimens. It

⁶ W. P. Headden, "A Study of Colorado Wheat," Part III, *Colo. Exp. Sta. Bul.* 219.

⁷ Jehiel Davidson and J. A. LeClere, "Effect of Various Inorganic Nitrogen Compounds Applied at Different Stages of Growth on the Yield Composition and Quality of Wheat," *Jour. Agr. Res.*, 23: 55, 1923.

⁸ H. E. Dadswell and L. F. Hawley, "Chemical Composition of Wood in Relation to Physical Characteristics. A Preliminary Study," *Ind. Eng. Chem.*, 21: 973, 1929.

would seem that the relatively higher lignin content makes the straw (or wood) brittle so that it tends to break under the violent impact of winds, whereas with a normal lignin content the plants only bend and straighten out again.

No explanation can be offered at present for the increase in lignin caused by nitrogenous hypernutri-

tion. It may be due to an effort on the part of the plant to overcome the weakening of the culms caused by the relative decrease in silica.

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THE NATIONAL ACADEMY OF SCIENCES. II

Salts of the enolic form of quinaldine: F. W. BERGSTROM (introduced by E. C. Franklin). Formally quinaldine is a ketone of the ammonia system because of the $\text{CH}_2\text{-C=N-}$ grouping, but the ketonic properties are generally subordinated to the stability of the six-membered ring. Nevertheless quinaldine reacts readily with liquid ammonia solutions of the ammonio bases, KNH_2 , NaNH_2 , LiNH_2 and $\text{Ba}(\text{NH}_2)_2$ to form salts. These salts are colored a deep red and are very reactive. A liquid ammonia solution of ammonium bromide reacts with them to form an unstable ammonium salt, or perhaps the pseudo quinaldine itself, which soon changes into ordinary quinaldine. Methyl iodide and ethyl bromide, in liquid ammonia solution, react to form, respectively, 2-ethyl and 2-n-propyl quinoline, a reaction akin to the alkylation of acetoacetic ester. The potassium salt of the enol modification of quinaldine is readily soluble in ether. The above-mentioned reactions can also be carried out in ether solution.

The rotation of the planets Uranus and Neptune determined from spectroscopic observations (illustrated): J. H. MOORE (introduced by R. G. Aitken). In 1911 Lowell and Slipher found from their spectrographic observations of Uranus that the planet is rotating in the same direction as that of the revolution of its satellites and with a period of $10\frac{1}{2}$ hours. Leon Campbell, Slavenas and others have reported a variation in the planet's light in very closely this period, while Stebbins, from observations made with the photoelectric photometer, concluded that the light of Uranus is constant. Recent observations obtained at the Lick Observatory with spectrographs of three-prism and one-prism dispersion confirm the direction of the planet's rotation as found by the Lowell observers. The period of rotation derived from fifteen one-prism spectrograms in 1928, 1929 and 1930 is of the order of that previously found. The three-prism spectrograms to which exposures of 6 hours were given are under exposed and difficult to measure. The period derived from two of these obtained in 1927 is 11.5 hours. A consideration of the probable sources of the discrepancy in observations of planetary rotation obtained with different spectrographs shows that for objects like Uranus and Neptune with small apparent disks the rotation period determined spectrographically is at best only approximate. Seven well-exposed spectrograms of Neptune were obtained with the one-prism spectrograph in 1928. The slit was placed parallel to the planet's equator, the position of which was derived by Eichelberger and Newton on the assumption that the well-known motion of the plane of the satellite's orbit is caused by the attraction

of an equatorial protuberance on the planet. All these spectrograms show a very noticeable inclination of the spectrum lines, in the sense that the portion of the line originating at the east limb of the planet is displaced toward the violet, indicating that the rotation of Neptune, like the other planets, with the exception of Uranus, is direct. The measured inclination of the lines yields an approximate period of rotation for Neptune of 15.8 ± 1.0 hours. The investigation of the rotation of Uranus and Neptune was carried on jointly by the author and Dr. D. H. Menzel.

Spectrophotometric measures of interstellar light-absorption (illustrated): ROBERT J. TRUMPLER (introduced by R. G. Aitken). The investigation of open star clusters recently furnished some definite evidence that within our Milky Way system light rays, passing through interstellar space, suffer a loss of intensity. Such a phenomenon is usually designated as "absorption" in the most general sense of the word. On the one hand the evidence is based on the fact that distances of open star clusters derived from their angular diameters do not agree with those derived from magnitudes and spectral types of the stars. On the other hand, we also find a change of color with distance for stars of the same spectral type, which indicates that the absorption is selective, i.e., that it depends on the wave-length of the light. In order to gain information on the physical process causing this absorption and on the nature of the absorbing medium, it is of prime importance to find the law according to which the absorption depends on the wave-length. For this purpose the spectra of the brighter stars in the clusters N.G.C. 6910 and N.G.C. 6913 (distance about 2,000 parsecs) were observed with the slitless quartz spectrograph of the Crossley Reflector and compared with the spectra of relatively near stars of the same spectral type. Taken on Panchromatic plates these spectra cover the region from 6300 Å to 3200 Å and show at once the great difference in the intensity distribution of the continuous spectrum between near and distant stars. This difference, which must be an effect of interstellar light absorption, was measured with a Moll self-registering microphotometer. The results show that the absorption increases rapidly with decreasing wave-length; but the absorption does not seem to be inversely proportional to the fourth power of the wave-length, which law should hold if the effect were due to Rayleigh scattering by extremely small particles.

Report on the completion of the research surveys of 1,091 minor planets: A. O. LEUSCHNER and H. THIELE.

The conclusion of the research surveys of 1,091 definitely known minor planets and partial revision of the manuscripts for publication was announced by the authors, who have been engaged on this work under the auspices of the National Research Council with the assistance of Mrs. Maud W. Makemson as chief assistant. The purpose of this work is to lay a foundation for future research on the motions of the minor planets by collecting in systematic form all the permanent results of the investigations made by astronomers on this subject since the discovery of the first minor planet at the beginning of the last century. Only material of fundamental value has been included in the research surveys, and results of temporary significance based on approximate methods have been eliminated. The research surveys are expected to form the beginning of a new era in the treatment of the motions of minor planets. It should now be possible to attempt a more precise valuation of the various methods of perturbations which have been applied in prediction and of the effectiveness of the programs of research followed at various national institutes for the determination of the motions of the minor planets.

Tables from the year 1930 to 2020 of the perturbations by Jupiter of twelve minor planets discovered by James C. Watson: A. O. LEUSCHNER and H. THIELE. In 1910 the senior author published investigations begun in 1901 under the auspices of the National Academy of Sciences by himself, with the assistance mainly of Professor R. T. Crawford and Astronomer F. E. Ross, of the perturbations by Jupiter of twelve of the minor planets discovered by James C. Watson. At that time it was hoped that the results might remain valid until about the year 1930, when, according to past experience, a revision of the extensive calculations was expected to become necessary. However, the departures of the planets concerned, as determined for the eleven years from 1918 to 1929, have been found immaterial for all practical purposes, so that the predictions based on the Berkeley calculations are now certain to hold for many decades to come, without revision. Under a grant from the Watson Fund the tables of perturbations of these twelve minor planets have been carried forward, from the original developments, from the year 1930 to 2020.

Aztatlan: prehistoric Mexican frontier on the Pacific coast: C. O. SAUER (introduced by A. L. Kroeber). In the course of field studies in 1930 numerous and extensive unreported prehistoric ruins were observed in the southern half of the state of Sinaloa and in northern Nayarit. Thirty-two sites were visited, all of which belong to one culture province. The largest ones and the most numerous are located in the great flood-plains, or on their margins. Others occur in residual basins of Piedmont position. Still others are found in the barranca country of the highlands and on coastal lagoons. The artefacts indicate that this region was a part of the Central Mexican culture complex. Archaic elements are present in many terra-cotta figurines, which were noted most

abundantly in the small upland sites. The large valley sites are of such mass and thickness of residuum as to indicate long occupation. The major part of the culture debris appears to belong to the great Toltec period. Polychrome pottery, elaborately engraved ware, obsidian knives, decorated spindle whorls and patterned cylinders are of greatest interest. In the flood-plain settlements mound building was practiced, which southward is developed into earth pyramids, apparently of sacrificial character. The culture area appears to cut off sharply north of the Culiacan Valley, though there are no physical obstacles to its expansion in that direction. No evidence was found of connection northward along the west coast with the presumably contemporaneous Pueblo culture. Two cultural sub-regions are recognized. The agricultural economy shows no dependence on irrigation. There is the suggestion that the older agriculture began on the drier lands. Everywhere it was based directly on rainfall or flooding. Present agriculture may be illustrative of prehistoric conditions. The development of agriculture in Middle America without irrigation, contrary to current assumption, is considered in the light of present practices and inferences drawn from the archeologic remains. The sites continued to be occupied into historic time as is shown by finds and also is inferred because their character and in part their position integrate very well with Spanish descriptions at the time of the conquest. The field finds confirm the Spanish accounts of extraordinary density and high culture of the native population. The existence of organized markets and of metal mining is established historically. From historical evidence the domestication of fowls other than turkeys is indicated. The fall of this culture is attributed entirely to historic causes. There is a doubtful persistence to the present of house forms, communities and linguistic elements.

Observations on the nature of the process by which mineral elements are accumulated by plant cells: D. R. HOAGLAND (introduced by T. Wayland Vaughan). Experiments carried on during recent years by several investigators prove that it is possible for plant cells to absorb various chemical elements against concentration gradients. Some experiments have been concerned with the fresh-water alga *Nitella clavata*, which produces cells large enough to be manipulated as separate units. The cell sap (containing very little organic matter) has an electrolyte concentration many times greater than that of the solution bathing the cells. Accumulation of certain ions (for example, bromine) against concentration gradients has been studied experimentally. This process has a high temperature coefficient and is dependent to a large degree on the illumination of the plant cells during the period of accumulation or on the after-effect of illumination. Unpublished data obtained more recently by F. C. Steward, using potato tissues, show that analogous accumulation of potassium and bromine may also occur in this case. However, the accumulation by potato tissue (containing stored carbohydrates) was shown to be dependent on the maintenance of proper conditions for oxidation, i.e., passage of a stream of air or oxygen.

Other experiments now in progress on excised barley roots give indication that accumulation requires a supply of oxygen and that the nature and extent of accumulation is modified in accordance with the metabolic conditions existing before excision of the roots. All the present data point to accumulation as a process involving cell metabolism and energy exchanges.

On the question of the uniformity of distribution of cosmic radiations: R. A. MILLIKAN. A new series of experiments of greater sensitivity than any the author has heretofore made has been carried out and new limits have been set to the possibility of an effect of direction and of latitude on the intensity of cosmic radiations. If there is any directional effect at all it can not amount to more than 1 per cent. at the most.

Remark on the nature of cosmic rays: P. S. EPSTEIN.

Application of the Geiger-Müller Ion-counter to the study of the space-distribution of X-ray electrons: E. C. WATSON and J. A. VAN DEN AKKER (introduced by R. A. Millikan). Investigations by Van den Akker have shown that with proper precautions the new tube counters can be used for the quantitative study of the intensities of weak electron beams. When used in the magnetic spectrograph to replace the photographic plate they offer the following advantages: (1) greater sensitivity, (2) greater resolving power, (3) a quantitative measure of intensity. Results of a detailed study of the space-distribution of the photoelectrons ejected by molybdenum characteristic X-rays from thin films of gold will be given and comparisons made with similar results obtained photographically.

A method of calculating spectroscopic terms in shells of equivalent electrons: W. V. HOUSTON (introduced by Robert A. Millikan). For a shell of equivalent electrons one can simplify the variational method suggested by Eckart. To each electron is assigned a hydrogen function containing a screening constant as a parameter, but for the shell of equivalent electrons all the screening constants may be taken to be the same. This parameter can then be determined by the variational method. If one term due to an electron configuration is known, all the electrons except those in the outer shell may be considered as merely screening the nucleus, and the amount of this screening can be determined from the known term. The other terms due to the same configuration can then be predicted from the theoretically determined parameters. These parameters also serve to give an estimate of the spin multiplet separations.

The spectrum of carbon in the extreme ultra-violet: I. S. BOWEN (introduced by R. A. Millikan). The spectrum of carbon in the extreme ultra-violet has been studied with the aid of a vacuum spark between very pure graphite electrodes. The lines, thus obtained, have been used to extend the analysis of the structure of the carbon atom in various stages of ionization.

A study of scattered X-radiation and electron momenta with the multicrystal spectrograph: JESSE W. M.

DUMOND and HARRY A. KIRKPATRICK (introduced by R. A. Millikan). A description is given of the multicrystal spectrograph, an instrument consisting of fifty small units, each a Seemann spectrograph in itself, co-operating to focus all their spectra in accurate superposition so as to form a single photographic spectrogram. This instrument is now being used in the study of X-radiation ($\text{MoK}\alpha$) scattered from graphite at various scattering angles. It permits of obtaining spectra of scattered radiation under far purer conditions of resolution and homogeneity of scattering angle with much great contrast (freedom from background) than have ever before been obtained without demanding exposures of unreasonable durations. According to a theory of DuMond's (*Phys. Rev.*, p. 643, May, 1929) the natural breadth and structure of the Compton shifted line is attributed to the velocities—or more accurately to the momenta—of the electrons in the solid body that scatters the radiation. On the assumption that conservation of momentum and energy holds for single processes of scattering of X-radiation by electrons it was shown that the Compton shifted line should be broadened in a way similar to the Doppler broadening of spectral lines emitted by moving atoms. A relation was developed between Compton line structure and the statistical distribution of electron momenta so that given either the other could be derived. In particular it was shown that the spectral breadth $\Delta\lambda$ of the Compton line should increase along with the shift as the scattering angle increases, and the exact functional dependence was predicted. Experimental proof of the existence of such a dependence of Compton line breadth on scattering angle has now been obtained with the multicrystal spectrograph and is presented in this paper. The evidence, therefore, for the correctness of DuMond's assumption that the structure of the Compton line is related to the distribution of electron momenta in the scatterer seems very strong, since no other explanation of the predicted and observed functional relations between breadth, shift and scattering angle is at present available. The line structures observed in metallic scatterers constitute confirmatory experimental evidence for the degenerate conduction electron gas of Fermi and Sommerfeld, and invalidate the applicability of the Maxwell-Boltzmann statistics to conduction or "free" electrons in metals.

Artificial gamma rays produced in a 600,000-volt electron tube: C. C. LAURITSEN (introduced by R. A. Millikan). A spectrograph of the Seemann type has been constructed for the purpose of investigating the radiation from the high potential X-ray tube at the California Institute. A typical spectrogram obtained with 600 kilovolts on the tube is presented. The photometer record shows a continuous spectrum with its maximum intensity at about 200 kilovolts and a short wave-length limit in the neighborhood of 600 kilovolts. The range covered is roughly from 100 to 20 x-units. It is proposed to use the apparatus for determining absorption coefficients by photographing the spectrum of radiation which has passed through an absorbing screen. No anomalies of any kind have been observed so far.

Critical elements in study of early man in southwestern United States: JOHN C. MERRIAM. The most ancient occurrences of human remains in southwestern United States present a problem of exceptional interest by reason of the fact that the record of associated life and the details of geological history are relatively more abundant than in many of the regions of the United States where effort has been made to work out the early history of man on this continent. Frequent crustal movements in the region of the Southwest have produced extensive and deep erosion, together with wide-spread and thick accumulation of deposits. In some localities the volume of material thus accumulated, the number of strata represented in the record and the multiplicity of geological incidents arranged in sequence present a background against which projection of the record of life becomes unusually interesting. The extent to which changes in the fauna and migration of life among regions of the Southwest shows relatively large number of changes is yet to be determined by working out of details in both geological and paleontological history. There is some reason for belief that the paleontological history will show a contribution comparable to that of the geological story of the Southwest. With the background of geological and paleontological data presented it becomes of exceptional importance to make intensive study of all remains of man found in the West and especially in the southwestern area of the United States. In connection with previous studies heavy emphasis has been placed on determination whether strata in which human remains have been found are of Pleistocene or Recent epochs. For the moment it is important to learn what the historical sequence is regardless of whether the remains happen to be Pleistocene, Late Pleistocene or Recent. Once the paleontological or archeological sequences are established it will be easier to determine the correlation with stages of the Recent or Pleistocene which have been accepted as standards.

Problems of antiquity presented in Gypsum Cave, Nevada: CHESTER STOCK (introduced by F. L. Ransome). Excavations conducted by the California Institute in cooperation with the Southwest Museum in Gypsum Cave, near Las Vegas, Nevada, reveal the presence of several mammalian types, including the extinct ground sloth (*Nothrotherium*), horse (*Equus*), mountain sheep (*Ovis*), and camel (*Tanupolama?*). The better preserved remains are found in a deposit consisting in large part of sloth dung. The most striking feature of the mammalian occurrence is the unusual preservation of the ground-sloth material. The collection includes in addition to the dung the horny sheaths of claws, hair, small pieces of skin, bits of dried flesh adhering to bones, as well as skull and skeletal elements. Artifacts have been found also in the deposits. The presence of remarkably well-preserved animal remains and cultural objects leads to a consideration of two questions of major importance in the history of Quaternary life in America: (1) Was man coexistent with some or all of the animal types recorded in the deposits? (2) What degree of antiquity in Quaternary time can be ascribed to the mammalian

fauna and more particularly to those types found in the dung layer? The occurrence at Gypsum Cave resembles in several respects that recorded some thirty years ago in Eberhardt Cavern, Last Hope Inlet, Patagonia.

A thermodynamic analysis of the function of the kidney; and some physiological applications: HENRY BOR-SOOK and HOWARD M. WINEGARDEN (introduced by T. H. Morgan). The work of the kidney in the excretion of urine is analyzed by means of the second law of thermodynamics. The work performed by the normal kidney in man in the excretion of urine is of the order of magnitude of 0.7 gm calories per cc of urine; or 70 gm calories per gram of nitrogen excreted. The production of either hypertonic or hypotonic urine entails work on the part of the kidney; the excretion of a urine which is the same as the plasma in all details incurs no work by the kidney. The energy consumed by the kidney in man in the production of urine was found to be 6-11 kg calories per gram of nitrogen excreted. The normal healthy kidney considered as a chemical machine possesses a great capacity for work but performs its work with an "efficiency" probably not greater than 1 to 2 per cent. The effect of disease is to reduce markedly the capacity of the kidney for work. This conception of renal function permits a correlation of observations on the constitution of amphibian and mammalian urine, *in situ* and isolated, in health and disease; of the effects of drugs, metallic poisons, anemia, cyanide and narcotics on the oxygen consumption of the kidney; and of the observations on the differences in renal oxygen consumption during the excretion of increased amounts of chlorides, sulfates and urea. There is a close correlation between the specific dynamic action of proteins or amino acids and the increase, over the basal level, in the urinary nitrogen. The values of the specific dynamic action of amino acids and of proteins indicate that 25 to 60 per cent. is due to the work imposed upon the kidney; the remainder is due to the metabolism of the constituent nitrogen and carbon, though it is not possible, at present, to estimate the proportion for which each is responsible. This hypothesis accounts for hitherto anomalous phenomena in the specific dynamic action of protein.

Haploid Drosophila and the theory of genic balance: CALVIN B. BRIDGES (introduced by T. H. Morgan). Some animal forms are known in which the cells of certain individuals contain only one set of chromosomes, instead of the usual two sets. These "haploid" individuals, of which the best known are in the bees and wasps, are invariably males. In *Drosophila melanogaster* sex is determined by the ratio between two sets of opposing genes, one set, tending to produce femaleness, being carried in the X-chromosome, and another set, tending to produce maleness, being carried in the rest of the chromosomes. Increasing the relative number of X-chromosomes increases the femaleness. Increasing the number of autosomes increases the maleness of the individual. A ratio (2X:3 sets autosomes), intermediate between that of the normal female (2X:2 sets auto-

somes) and the normal male (1X:2 sets autosomes) gives sex-intermediates or intersexes. Since a similar relation exists for other characters, it is evident that the degree of development of a character is an expression of an equilibrium between genes tending to modify the character in opposite directions. This theory is given the name "genic balance." Now in *Drosophila* it was found that 2X:2A, 3X:3A and 4X:4A, all 1:1 ratios, give the female type of characters. Therefore it was predicted that 1X:1A, or the haploid type, should be female, if the theory of genic balance is valid. No haploid *Drosophilas* were known, but a method was discovered which would give individuals in whose bodies, in sharply delimited regions, haploid tissue is present. These individuals occur rarely, one in many thousands, among offspring that start as Minute-n females. The gene Mn evidently affects the X-chromosome in which it lies, and to a lesser extent the other maternal chromosomes present in the same egg-cell, in such a manner that they can not maintain the normal division pace. Hence they are all rarely left behind and lost. The cells from which all maternal chromosomes are lost still contain the paternal X and autosomes and give a haploid patch of tissue. For several years attempts have been made to obtain more definite evidence, first, that these patches are actually haploid in the manner just represented, and second, to determine the sex of the haploid regions. The haploid nature of these regions and their femaleness are both now sufficiently established. One recently discovered especially favorable specimen showed in a haploid region the loss of dominant maternal characters which were carried by the three major chromosomes, here eliminated, and the presence of recessive paternal characters which were carried by the three corresponding chromosomes of the father. The sex was diagnosed as female from the darker color of the eosin eye of the region, and from the absence of sex combs, which when present are a distinctive and reliable index of maleness. The unusual nature of the case of a haploid that is female lends strong support to the theory of genic balance, on the basis of which this condition was predicted.

The inheritance of rubricalyx bud color in crosses with Oenothera lamarckiana: STERLING EMERSON (introduced by T. H. Morgan). Three types of F₁ plants, all with rubricalyx bud color, are produced in crosses between *Oenothera Lamarckiana* and *Oe. rubricalyx* (Afterglow). The *gaudens* complex of *Lamarckiana* with modified-velans of rubricalyx produces a plant with the *Lamarckiana* growth habit and a ring of 12 chromosomes and a pair. On inbreeding, *gaudens* modified-velans breeds true for bud color, growth habit and chromosome configuration, indicating that the genes for bud color, growth habit and the zygotic lethals of *gaudens* and modified-velans are in the ring of 12 chromosomes. *Gaudens* with *latifrons* of rubricalyx produces a plant which resembles *Lamarckiana* in growth habit and has a ring of 8 chromosomes and 3 pairs. On inbreeding, it produces plants of the F₁ type and a second type which has homozygous rubricalyx bud color, the bud shape of

mut. *latifrons*, and 7 chromosome pairs. Growth habit is variable in both types. In *gaudens* *latifrons*, therefore, the *gaudens* lethal and the gene for rubricalyx bud color are in the ring of 8 chromosomes, while some of the genes for growth habit are in some of the pairing chromosomes of the F₁ plant. The *latifrons* complex carries no lethal, which accounts for the appearance of the segregate with 7 chromosome pairs. The *velans* complex of *Lamarckiana* with *latifrons* produces a plant with the rubricalyx growth habit and a ring of 8 chromosomes and 3 pairs. On inbreeding, four types of plants are produced: rubricalyx-habit with rubricalyx buds, rubricalyx-habit with red buds, *latifrons*-habit with rubricalyx buds and *latifrons* habit with red buds. Both types with rubricalyx growth habits have a ring of 8 chromosomes and 3 pairs, and both types with *latifrons* growth habits have 7 chromosome pairs. In *velans* *latifrons*, therefore, the *velans* lethal and the genes for growth habit are in the ring of 8 chromosomes, while the gene for rubricalyx bud color is in one of the pairing chromosomes. The linkage between the genes for rubricalyx bud color, growth habit, and the *velans* lethal in certain hybrids is thus due to the association of chromosomes in the rings and not to the presence of all these genes in a single chromosome.

A spectrophotometric study of the pigments in the eye-color mutations of Drosophila: JACK SCHULTZ (introduced by T. H. Morgan). The many eye-color mutants of *Drosophila* furnish material for the study of problems in the physiology of gene expression. As a first step in such a study, the pigments concerned have been investigated by means of spectrophotometric measurements of their absorption curves. In the twenty eye-color types so far studied three water-soluble pigments—red, yellow and brown—have been found. The first two of these show characteristic color changes with change of pH. The brown pigment, when the solution is made alkaline, darkens, but does not change in color. All three of the pigments follow the portion of an extract which contains the amino-acids; they may possibly be related to this group of substances. Partial separation of the pigments from each other, out of mixtures, has been accomplished in various ways. On the addition of excess acid or on heating the dry pigment, both yellow and red are changed into the brown pigment, which itself is stable under such treatment. As yet the reverse change has not been brought about. The conversion of two of these pigments into the third, as well as the general similarity of their group reactions, indicates that they are closely related. The different eye-colors may be grouped into four general classes, according to the pigments they contain. Three of these correspond to the three pigments, each group containing one pigment in high concentration compared to the others. The fourth group contains those types in which mixtures of the three pigments are present. Genetic combinations have been made of mutants from different groups and the pigments present in these combinations studied. These data may perhaps be interpreted to mean that the genes involved affect the reaction which forms the pigment out of its precursor,

and that these three pigments may possibly have the same precursor.

Function space-time manifolds: A. D. MICHAL (introduced by E. T. Bell). This paper is concerned with one-parameter continuous groups of transformations and their functional invariants in the infinitely many dimensional manifold each point of which has coordinates $(y(x), t)$.

The motion of a solid in a compressible fluid: H. BATEMAN. For the case in which the motion of the fluid relative to the solid is steady and irrotational the equations of motion may be derived from the principle that the pressure-energy of the fluid is stationary in value (a maximum usually) when the mechanical energy per unit volume is a prescribed function of the density. The pressure-energy can be expressed as the volume integral of a certain function of the velocity, and the problem has many features in common with the well-known problem of minimum area associated with the form of a soap film. The case in which the velocity of the fluid is of the same order of magnitude as the velocity of sound in the fluid is particularly interesting both on account of its technical importance and also on account of many peculiar phenomena. The theorem of Prandtl and Glauert relating to the effect of compressibility on the lift of an airfoil is extended to the case when there is a very general type of relation between the pressure and density of the fluid.

Wave motion in a homogeneous absorbing medium: P. S. EPSTEIN.

Velocity-distance relation among extra-galactic nebulae: EDWIN HUBBLE. Earlier investigations have established an approximately linear relation between radial-velocity and distance (the red-shift) among extra-galactic nebulae, amounting to about 500 km/sec per million parsecs and holding out to about two million parsecs. Thirty-four new velocities, sixteen of which are distributed among four very distant clusters of nebulae, confirm the relation in its earlier form and extend the observed range out to about 24 million parsecs. Distances of clusters and groups of nebulae are determined from the mean magnitudes, the zero-point being derived from nebulae in which stars can be seen. Extra-galactic nebulae appear to exhibit a color-excess which is independent of distance and may have its origin in the galactic system itself.

Forbidden iron lines in stellar spectra: PAUL W. MERRILL. The bright-line spectrum of the famous southern variable star η Carinae was well known to astronomers for many years but until recently numerous strong lines remained unidentified. The same lines had been observed in a few other stellar spectra. Shortly after Bowen announced the discovery in the spectra of nebulae of so-called forbidden transitions from metastable states of oxygen and nitrogen atoms, the lines resulting from similar transitions in ionized iron atoms were computed and found to coincide with most of the strong uniden-

tified lines in η Carinae. An essential distinction between these lines and those known in the laboratory is that the probability of spontaneous transition from the initial (upper) state is much smaller. They correspond to quadrupole rather than to dipole radiation. The forbidden iron lines are now known in about twenty stars, including eight or ten associated with class B, one or two of class G, three or four long-period variables just before minimum light, five other red stars and two novae. The spectrum of H.D. 190073 exhibits numerous bright iron lines, although the forbidden lines are apparently absent. It is of especial interest, however, because of the presence of bright sodium lines. Aside from novae this is the first star in which these familiar lines have been observed to be bright.

Mount Wilson measures of lunar and planetary temperatures: EDISON PETTIT and SETH B. NICHOLSON (introduced by Walter S. Adams). The temperature of a planet is given by the general equation $\log T = 2.612 - 0.1(\bar{m}_r - \Delta m_r)$ where \bar{m}_r is the radiometric magnitude of the planetary heat per square second of arc, and Δm_r is the absorption loss in the atmosphere and the telescope. The radiation from each planet was measured with a thermocouple placed in the principal focus of the 100-inch reflector; the radiated planetary heat, from which \bar{m}_r is obtained, was separated from the reflected sunlight by means of a thin glass absorption screen. The atmospheric absorption was derived by extrapolation from Fowle's laboratory measures of the transmission of water-vapor and from a comparison of measured and computed maximum temperatures on the moon. The radiation from the moon was measured during a total eclipse, and from the rate of cooling some idea of its heat conductivity was obtained. The resulting temperature of the sub-solar point on the moon was 374° K, and of a point on the night-side, less than 120° K. The temperature of a point where the altitude of the sun was about 20° fell from 342° K before the lunar eclipse to 156° K after $2^h 40^m$ immersion in the umbra of the earth's shadow. The maximum temperature of Mercury is about 655° K. The distribution of radiation over its surface is much like that on the moon. Venus is covered with clouds and the radiation measured is from the high cloud surfaces and, except by inference, tells very little about the actual surface temperatures. The measured night temperature on Venus is about 241° K which is much higher than that on Mercury or the moon. The temperature on Mars varies greatly with the season and the time of day. With the sun in the zenith at perihelion it measures 296° K; at aphelion this temperature would be reduced 27° . The outer planets are very cold, as might be expected from their great distances from the sun, unless they give off heat from their interiors. The thermocouple measures show that the temperature of Jupiter is about 135° K and, therefore, that very little of the radiated heat comes from its interior.

The photochemical reaction of gaseous iodine with hexene, and the separation of the two types of iodine molecules: R. M. BADGER and J. W. URMSTON (intro-

duced by A. A. Noyes). It was the purpose of the experiments here reported to attempt a separation of the symmetric and antisymmetric types of iodine molecule by means of a photochemical reaction in which one of these molecular types is selectively activated. The selective activation was effected by irradiation with the green mercury line, 5461 Å, which is absorbed by only one of the molecular types, and the acceptor chosen for the activated molecules was gaseous hexene. If the photochemical reaction were of the simplest kind, namely the addition of the activated iodine molecules onto the hexene double bond, the reaction would proceed until half the iodine is used up, the molecules remaining being of the type which does not absorb the green mercury line. Experiments on mixtures with a partial pressure of iodine of about 0.17 mm and of hexene of about 6. mm show that the mechanism of the reaction is actually more complicated, and may possibly involve energy transfers between the two types of iodine, or the production of iodine atoms at some stage of the process. However, fluorescence experiments on mixtures in which half the iodine had reacted indicated a small but definite excess of the molecular type which does not absorb the 5461 Å line, over that found in the equilibrium iodine mixture. This excess does not disappear in several days when the gas mixture is kept in the dark.

The ring structure of mannose: HORACE S. ISBELL (introduced by George K. Burgess). The ring structure of the various forms of glucose and mannose has been the subject of considerable controversy. It has been claimed (Hudson, *Jour. Amer. Chem. Soc.*, 52: 1682, 1930) that a decision between the rival classifications of rings might be obtained from a comparison of the optical rotations of a pair of sugars which can exist only in one ring form. Two pairs of substances which fulfil these requirements, cellobiose and 4-glucosido-mannose, and lactose and 4-galactosido-mannose, were pointed out by C. S. Hudson. A comparison of the approximate rotations of these sugars as given in the literature shows that the difference between the molecular rotations of the first pair differs widely from the value obtained for the second pair. Thus it was necessary to obtain more accurate data upon the rotations of these substances. The preparation of 4-glucosido- α -mannose monohydrate has been repeated and the initial rotation as extrapolated to zero time was found to be $[\alpha]_D^{20} = 14.6$. A comparison of the molecular rotations of cellobiose and 4-glucosido- α -mannose gives an "epimeric" difference of 16,900. This is of the same order of magnitude as the values obtained from α -mannose and α -methyl mannoside, 14,900 and 15,300, respectively, but it differs markedly from the value 6,700 obtained from β -mannose. On the other hand, a comparison of the approximate rotations of 4-glucosido- β -mannose and 4-galactosido- β -mannose indicates that they agree with the value derived from β -mannose. These results are interpreted as indicating that 4-glucosido- α -mannose has a structure similar to α -mannose, while 4-glucosido- β -mannose and 4-galactosido- β -mannose have structures similar to β -mannose.

Since the disaccharides just mentioned can not form a 1, 4 ring, probably neither α - or β -mannose has a 1, 4 ring structure.

Crystalline alpha and beta methyl-d-gulosides: HORACE S. ISBELL (introduced by George K. Burgess). The reaction between reducing sugars and methyl alcohol in the presence of hydrogen chloride gives a mixture of isomeric methyl glycosides. Frequently amorphous products are obtained which can not be brought to crystallization by the usual methods. The separation of two isomeric methyl gulosides from such a mixture was accomplished by means of crystalline coordination compounds with calcium chloride. So far as known these compounds are the first compounds of this type to be prepared from the methyl glycosides. The calcium chloride was removed by means of silver oxalate, and crystalline α -methyl-d-guloside (monohydrate) and β -methyl-d-guloside were obtained for the first time. The following new compounds are reported:

α -Methyl-d-guloside $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$,	$[\alpha]_D^{20} = + 67$.
$(\alpha\text{-Methyl-d-guloside})_2 \text{CaCl}_2 \cdot 3\text{H}_2\text{O}$,	$[\alpha]_D^{20} = + 83$.
α -Methyl-d-guloside $\cdot \text{H}_2\text{O}$,	$[\alpha]_D^{20} = + 109$.
β -Methyl-d-guloside $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$,	$[\alpha]_D^{20} = - 46$
(approximately).	
$(\beta\text{-Methyl-d-guloside})_2 \text{CaCl}_2$,	$[\alpha]_D^{20} = - 65$.
β -Methyl-d-guloside,	$[\alpha]_D^{20} = - 83$.

BOOKS RECEIVED

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